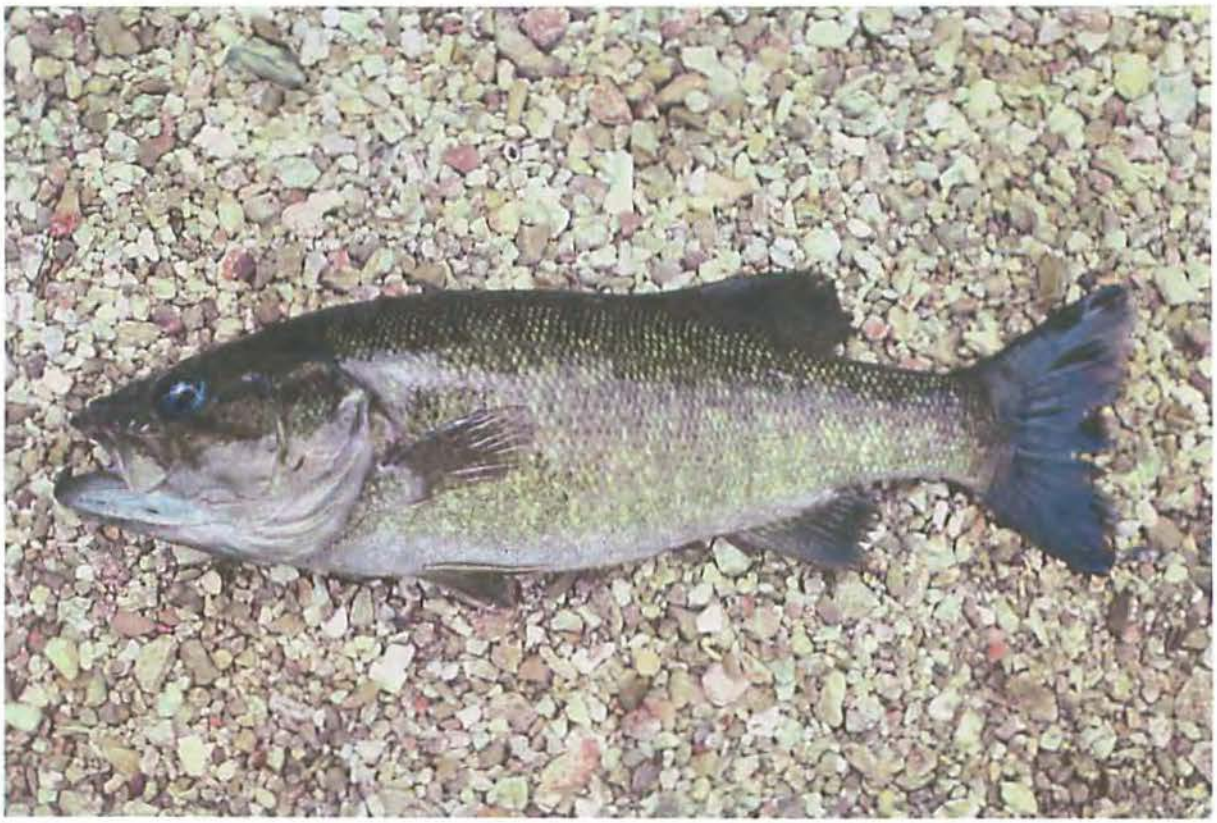
Stream Black Bass Special Management Areas Summary for Smallmouth Bass

Project and Data Summary



Prepared by: Kevin Meneau, Smallmouth Bass Species Coordinator

Approved by: Bill Turner, Fisheries Division Chief

Date: Nov. 25, 2009

EXECUTIVE SUMMARY

This report summarizes smallmouth bass angler survey and electrofishing data from Stream Black Bass Special Management Area (SBBSMA) surveys which occurred during 1990-2007. SBBSMA evaluations consist of data collected before and after implementation of a 15-inch minimum length limit, daily limit of one (two daily limit on all black bass on Elk River) special regulation imposed on smallmouth bass in 12 reaches of 10 streams. In addition, a summary of Missouri stream smallmouth bass research and management is provided.

Evaluation results include:

1. Angler catch of smallmouth bass increased for all sizes evaluated after implementation of special regulations.
2. Electrofishing catch of smallmouth bass showed modest increases after implementation of special regulations.
3. Total angling effort and trips declined after implementation of special regulations; however, black bass effort remained relatively stable.
4. Though most smallmouth bass indices showed improvement after implementation of special regulations, they fell short of objectives to double numbers of 12-15" and ≥15" smallmouth bass without any loss in fishing effort. Increase in smallmouth bass ≥18" satisfied the established objective.

Disclaimer: *Big, Big Piney and Meramec River angler survey data presented in this report should be considered provisional. If data refinement occurs at a later date, angler survey portions of this report may be updated.*

INTRODUCTION AND BACKGROUND

Much like turkey hunting may be the quintessential Missouri hunting experience, Ozark stream float fishing for smallmouth bass may be considered the classic Missouri fishing experience. In recognition of the importance of this fishery, Missouri has a rich history of stream smallmouth bass management.

Early stream black bass management concentrated on determining how many fish Missouri streams could produce, how fast bass grew and how to protect and improve smallmouth bass fishing. Although Ozark streams generally provide good smallmouth bass habitat, smallmouth bass comprise a relatively small proportion of most stream fish communities. Missouri stream smallmouth bass biomass estimates ranged from 3.1 to 16.1 pounds per acre for the Big Piney and unexploited Big Buffalo Creek, respectively, (DeJaynes and Turner 1991). Funk (1959) found smallmouth bass biomass comprised only 13% of the fish communities in Courtois and Huzzah creeks. Funk (1975) found a similar trend nationally, with smallmouth bass comprising only 7% of stream fish biomass.

Despite comprising a relatively low proportion of the stream fish community, stocking smallmouth bass did little to increase that proportion or significantly improve stream bass numbers (Novinger 2003a). Fleener (1968) and Funk and Fleener (1974) found stocking fingerling smallmouth bass into Current River tributaries and the mainstem Big Piney River had little or no impact on bass density or return to angler creels. Along with Pflieger (1974), they also found year class strength in Missouri streams is erratic due to environmental conditions, primarily the timing of floods. Flooding prior to spawning or after hatching improved year class strength; the opposite was true for flooding during spawning. However, natural reproduction filled available habitat and produced strong year classes one out of four years. Pflieger (1974) found large year classes negatively affected success of fry and fingerlings produced the following year, possibly due to cannibalism and competition.

Stream smallmouth bass grow relatively slow. In most streams, it takes the average smallmouth bass over four years to reach 12 inches, over six years to reach 15 inches and over eight years to reach 18 inches (DeJaynes and Turner 1991). Slowest growth occurred in headwater streams, while fastest growth occurred in lower stream reaches (Purkett 1958). Stream smallmouth bass tend to grow slower than those in lakes. Patriarche and Campbell (1958) found Black River smallmouth bass grew 17% slower than their Clearwater Lake cousins, with a greater disparity for younger fish.

Missouri seasonal harvest restrictions for black bass date back to the 1940s. Fleener and Funk (1957) studied impacts of year-round angler harvest on smallmouth bass in the Niangua River from 1951-62. They determined annual closure of the harvest season would protect adult bass, which led to the first seasonal stream bass harvest closure (1965) and was a precursor to the current March 1 through the Friday before the fourth Saturday in May closure.

Studies by Fajen (1972 and 1975a), Fleener (1975) and Russell (1974) led to the establishment of the current statewide 12-inch minimum length limit in 1974. A statewide, six-per-day harvest limit for stream black bass was established in 1961.

Spotted (Kentucky) bass introduction or migration into traditionally largemouth/smallmouth bass streams has led to competition between the black bass species (Fajen 1991). Spotted bass tend to establish themselves in lower gradient streams and stream reaches with slightly warmer water temperatures than smallmouth bass which remain dominate in cooler, higher gradient streams and reaches. In addition, hybridization of smallmouth and spotted bass and backcrossing of hybrids occurred and was seen as a significant factor in speciation of black basses, especially when species interaction was recent (Pfleiger and Fajen 1975). Baumann (1945), Pfleiger (1975) and Fajen (1981a) have indicated smallmouth bass abundance declines in Ozark border streams are common. Some populations have been replaced by largemouth or spotted bass Fajen (1981a and 1991) and may relate to large scale land-use changes (Sowa and Rabeni 1996). In response to spotted bass expansion in the Meramec River basin, spotted bass regulations were relaxed in all Meramec River watershed streams (1,733 miles of streams) in 2002 to allow harvest of up to 12 spotted bass per day with no minimum length limit.

Efforts in the 1980s and 1990s focused on angler preferences, smallmouth bass habitat, stream bass movement, smallmouth bass diet, bass sampling techniques and improving stream bass populations. Surveys have shown Missourians enjoy bass fishing. Weithman (1994) found that black bass were preferred by 50% of Missouri anglers surveyed, second only to catfish. Special management area (SMA) angler surveys from the Big, Big Piney and Meramec rivers (1991-96) indicated that 54% of all fishing pressure was devoted to black bass, primarily smallmouth bass (unpublished data, Austin, Fuller and Meneau, MDC).

The 1996 statewide angler survey (Weithman 1996) indicated that 33% of Missouri anglers mentioned that black bass fishing in Missouri could be improved and that 77% felt stream fishing quality could be improved. The majority of Big River anglers (55%) and Big River bass anglers (64%) surveyed from 1995-96, supported extending the existing SMA by 52 miles (unpublished data, K. Meneau, MDC). Although increasing the statewide minimum length limit could arguably do more harm than good (reduced fishing quality through reduced growth rates, over-crowding of predator fish and decreased amounts of prey) in many streams, angler support for increased protection of smallmouth bass is apparent.

Concerns about Missouri anglers not desiring special regulations may not be supported by surveys of Missouri anglers. Weithman (1994) found anglers did not think reducing the number of regulations was an effective way to improve fishing quality. In fact, 50% of Missouri anglers felt fishing regulations had a major positive effect on fishing quality. Weithman felt the public would generally support additional fishing regulations which improve fishing quality (e.g., catching more and bigger fish).

Physical stream factors, such as water temperature, habitat, food availability, water quality and streamflow heavily-influence smallmouth bass growth rates. Along with appropriate water temperature, combinations of good depth, abundant cover and adequate stream flow velocities provide optimum conditions for smallmouth bass. Covington et al. (1983) found Jacks Fork and Current River smallmouth bass densities, biomass and production were highest in association with the greatest abundance of boulders, considerable depth and steep banks. Probst et al. (1984) found Jacks Fork smallmouth used aquatic vegetation and boulders in slow velocities when young, and sought log complexes in swifter, deeper water when older. Sowa and Rabeni (1995) and Zweifel et al. (1999) found increasing maximum

annual water temperatures (above 73^0F) and percent pool area reduced smallmouth bass densities in Ozark border streams. Whitledge et al. (2006) found that restoring or maintaining riparian shading of spring-fed warmwater streams would benefit smallmouth bass growth and densities. In addition, Sowa and Rabeni (1995) found increasing embeddedness and pool:riffle ratio negatively impacted smallmouth bass.

Larger (basin-level) scale factors, such as: geology, topography, gradient, elevations, area, streams size and discharge may impact smallmouth bass more than microhabitat features such as current, velocity and substrate (Novinger 2003b). Rabeni (1990) suggested good smallmouth bass angling can only occur when satisfactory habitat is maintained over the long-term. Sowa and Rabeni (1996) reported that only when basin-level habitat variables are appropriate for smallmouth bass will microhabitat variables become important. Though many other factors are probably involved, there is a notable negative relationship between smallmouth bass density and valley width; smallmouth bass densities appear to be greatest in upstream reaches where narrower valley width dominates.

Experimental habitat improvement projects began in the 1970s and 80s. Habitat loss in channelized streams can mean up to a 90% decline in fish production (Fajen 1981a). Improving in-stream smallmouth bass habitat in channelized streams proved difficult and somewhat unpredictable in Big Buffalo Creek (Fajen 1982). Use of cedar tree revetments and willow planting techniques were developed to stabilize streambanks in the 1980s and were part of Missouri Department of Conservation (MDC) stream management workshops provided for biologists (MDC 1992). Since then, a variety of rock-oriented structures (e.g., weirs, hard points, vanes) have been installed to stabilize channels and streambanks on medium to large streams. However, no direct relationship between these structures and smallmouth bass populations has been established.

Smallmouth bass movement outside of home reaches appears to be minimal, providing an opportunity to manage populations within discrete reaches. Rabeni and Jacobsen (1993) noted that smallmouth bass (age 2 and older) have a relatively small home range (0.5-acre) in the Jacks Fork River. Tagging studies performed by Funk (1956), Todd (1987) and Todd and Rabeni (1989) confirmed that most smallmouth bass are born, live and die in a very finite area, many times within a single pool/riffle complex. However, some upstream movement in headwater streams or significant seasonal movement may occur. Todd (1987) found increasing photoperiod and temperature increased smallmouth bass movement within pools. Todd and Rabeni (1989) found adult smallmouth bass may leave their home pool prior to spring spawning activity. Seasonal movements may be more pronounced in streams with major springs (Peterson and Rabeni 1996), as fish seek out thermal refuge in winter.

Smallmouth bass diet studies demonstrated strong preferences for crayfish and small fishes. Distefano (2005) found crayfish made up to 65% of smallmouth bass diets in Ozark streams. However, larger smallmouth bass increasingly utilized crayfish. Though juvenile smallmouth bass ate some crayfish, once smallmouth bass became seven inches in length, crayfish were their main source of energy for the rest of their lives. Other important food items included fish and insects. Probst et al. (1984) found crayfish were the most important contributor to smallmouth bass caloric intake, followed by fish and insects. Livingstone and Rabeni (1991) found Jacks Fork River under-yearling smallmouth bass derived 80% of their caloric intake from small fish.

Sampling methods for stream smallmouth bass populations were discussed or investigated by several investigators. Turner et. al. (1991) described the standardized sampling protocol utilized by many Missouri stream biologists which includes use of direct current (DC) electrofishing boats during September/October daytime surveys. Roell (1993) and Turner (1994) found smallmouth bass less than nine inches in size were not fully vulnerable to electrofishing. Roell also suggested that sampling in deep pools is limited by effective sampling depth of electrofishing equipment. Turner (1994) found no clear differences existed in catch rates during day or night sampling or between spring and fall seasons; however, smallmouth bass average length was greater during spring samples. Turner also found electrofishing sampling effectiveness was dependent on sampling conditions (mainly stream discharge) and size of the river, with small to medium-size Ozark streams being more successfully sampled than larger ones.

Management of stream smallmouth bass using special regulations has occurred or been evaluated primarily on individual streams or stream reaches. Fleener (1974) found the 12-inch minimum length limit (mll) cut the time anglers needed to catch a smallmouth bass in half. Fajen (1975b) found Courtois Creek smallmouth bass numbers doubled with a slight decrease in growth rate from a five-year "fish-for-fun-only" study, as compared to no length limit. However, Smith (unpublished MDC data 1991) and Fajen (1981b) later found similar population structure with statewide regulations (12-inch mll). In the early 1990s, an angling mortality study on Big Buffalo Creek found little difference in smallmouth bass mortality between lure and live bait angling methods (Turner 1992), demonstrating little need for bait or lure restrictions. Reed (1987) characterized the smallmouth bass populations of Big Buffalo and Pole Hollow creeks as resembling unexploited populations. To diversify angler opportunities, fishing was opened with special catch-and-release regulations in 1994. It soon became apparent that years of habitat degradation severely-impacted their smallmouth bass populations, demonstrating the futility of applying special fishing regulations to waters without adequate habitat. After 10 years of mandatory catch-and-release, smallmouth bass special regulations were changed to statewide regulations in 2004.

In 1989, MDC fishery managers formed the Smallmouth Bass Work Group (SMBWG) to consider an Issue Resolution which expressed a need to re-examine stream smallmouth bass management. This resolution suggested statewide regulations did not protect smallmouth bass long enough to reach a "quality" size in at least some selected streams. The SMBWG agreed that "there is need for a greater diversity and/or higher quality of [stream] black bass angling experiences, in water accessible to the public, then the present regulations provide." Although the definition of "quality size," regulation choices and project streams remained elusive, the SMBWG decided upon two general objectives:

1. Provide more, big stream bass; and
2. Provide greater total numbers of bass – these objectives may not be mutually exclusive, but may be attempted in different streams with different tools.

The effort was further refined by featuring management and research evaluations of two regulations: 15-inch and 18-inch minimum length limits (mll). In 1991, the first management evaluations began on Stream Black Bass Special Management Area (SBBSMA) sections of the Big, Big Piney and Meramec

rivers in anticipation of a 15-inch mll, daily limit of one regulation change during 1992. Middle and lower reaches of these larger Ozark streams were selected because of perceived habitat quality and their recognized ability to support quality smallmouth bass populations and average or better smallmouth bass growth rates. Objectives for these SBBSMAs were:

1. **Double the numbers of 12-14.9" smallmouth bass;**
2. **Double the numbers of ≥15" smallmouth bass; and**
3. **Increase the numbers of ≥18" smallmouth bass.**

Additionally, angler effort should be maintained at a level equal to or greater than present.

Electrofishing and angler surveys were performed during 1991-1996 and revealed some encouraging information. Angler surveys showed anglers in the SBBSMAs caught more and larger smallmouth bass faster than before. Early electrofishing data showed similar, but more modest results.

In 1995, MDC's Fisheries Division Research staff launched a project to determine impacts of an 18-inch mll, daily limit of one regulation on sections of the Gasconade and Jacks Fork rivers. Research evaluation objectives were:

1. Determine the effect of an 18-inch mll on smallmouth bass and on angling success and acceptance of the special regulation by anglers;
2. Determine changes in abundance, size structure, exploitation rates, total mortality and catch-and-release mortality of smallmouth bass and rock bass following implementation of new mll regulations; and
3. Recommend strategies for developing high-quality smallmouth bass fisheries in Ozark streams

A final report (Kruse and DeiSanti 2002) found slight increases in smallmouth bass densities on regulated portions of the Jacks Fork and Gasconade rivers, while size structure improved somewhat on the Gasconade. They felt differences in exploitation rate, growth rate and available smallmouth bass habitat favored enhanced population improvement in the Gasconade. They also concluded that harvest restrictions may not improve smallmouth bass density or size structure when existing angler exploitation is low and natural mortality is high.

Strong MDC support, initial SBBSMA evaluation findings on the Big, Big Piney and Meramec rivers, completed research evaluations and interest from anglers prompted the reconvening of the SMBWG in 1998. The SMBWG reaffirmed support for the SMA approach and adopted a statewide effort to identify, study and (where appropriate) improve stream smallmouth bass fishing by adopting the *Smallmouth Bass Special Management in Missouri Streams* (White Paper) in 1998. The White Paper called for biologists to evaluate 35 reaches on 33 candidate streams (Appendix 1) using nine criteria to determine if fishing regulation changes could improve smallmouth bass fishing (Meneau 1998).

In 2006, work outlined in the White Paper was completed (Meneau 2009). Evaluations resulted in establishment or extension of eight additional SBBSMAs resulting in a total of twelve areas on 358 miles of streams. A 15-inch mll and a daily limit of one regulation for smallmouth bass was implemented on

SBBSMAs on Big River (two extensions), Eleven Point River, Joachim Creek, Mineral Fork Creek, Osage Fork of the Gasconade River and Tenmile Creek. On Elk River a 15-inch mll and daily limit of two regulation for all black bass was implemented. Criteria most responsible for rejecting candidate streams from becoming SBBSMAs were lack of quality smallmouth bass habitat and concerns over support of potential special regulations.

This report summarizes results from SBBSMA stream evaluations performed by MDC staff and provides a basis for recommendations regarding future smallmouth bass management in Missouri.

RESULTS

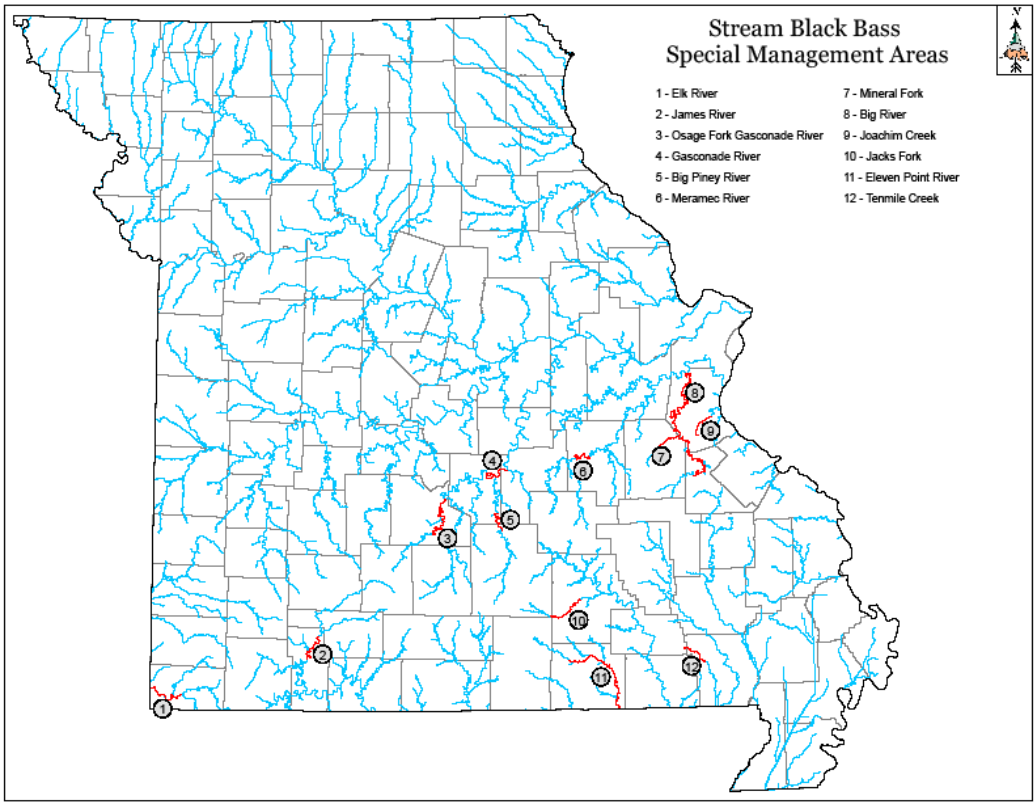
Stream Black Bass Special Management Areas Evaluations

In 1989, MDC fishery managers formed the Smallmouth Bass Work Group (SMBWG) which led to development of Stream Black Bass Special Management Areas (SBBSMA) concept and evaluations of 15-inch mll, daily limit of one special regulation on sections of the Big, Big Piney and Meramec rivers (Figure 1).

As the Big, Big Piney and Meramec SBBSMA evaluations were being completed, SBBSMAs were added on James River (1996), Tenmile Creek (1999), Big River (area extension; 2000), Mineral Fork Creek (2000), Osage Fork of the Gasconade River (2000), Eleven Point River (2000), Elk River (2004), Big River (area extension; 2004) and Joachim Creek (2006) through implementation of the Smallmouth Bass White Paper (Meneau 2009) to complete the list of management evaluations summarized in this report (Figure 1). In addition to maintaining angler effort at a level equal to or greater than that existing, management objectives for SBBSMAs were:

1. Double the numbers of 12-14.9” smallmouth bass;
2. Double the numbers of $\geq$15” smallmouth bass; and
3. Increase the numbers of $\geq$18” smallmouth bass.

Figure 1. Missouri's Stream Black Bass Special Management Areas, 2009.



Management evaluations were completed for twelve SBBSMAs during 1990-2007 (Table 1). All streams were surveyed by day-time electrofishing using standardized, DC-pulsed electrofishing boats or tote barges according to procedures outlined in the Smallmouth Bass Standardized Sampling Guidelines (Turner et. al. 1991). Control area data were collected for sections adjacent to SBBSMAs on the Big, Big Piney, James and Meramec rivers and Osage Fork (Table 1). In addition, the Big, Big Piney and Meramec rivers' control areas and SBBSMAs were evaluated with probability, access angler surveys during 1991-1996. Data from these angler surveys are provisional.

Table 1. Stream Black Bass Special Management Area Evaluation Data Collection, 1990-2007.

Stream	County	Miles	Pre-SBBSMA Data Years	Control Data Years	Post-SBBSMA Data Years	Regulation Implemented
Big River[1]	Jefferson/Washington	10.7	1991	1992-1999	1992-99, 2002-07	**1992**
Big River[2]	Jefferson/Washington	52.3	1990-97, 1999	--	2002, 2003-04	**2000**
Big River[3]	Jefferson, St. Francois & Washington	43	2000-03	--	2004-07	**2004**
Big Piney	Texas/Pulaski	15.5	1990-91	1990-93, 2001-02, 2004, 2006	1992-93, 1999, 2001-02, 2004, 2006-07	**1992**
Eleven Point River	Oregon	50	1998-99	--	2000-07	**2000**
Elk River	McDonald	22	1998-99, 2000-01, 2003	--	2005-07	**2004**
James River	Stone	22	1992-95	1992, 1998, 2002	1997-98, 2001-02	**1996**
Joachim Creek	Jefferson	18	2001	--	2006	**2006**
Meramec River	Crawford	14.9	1990-91	1990-98, 2002, 2004, 2006	1992-96, 1998-99, 2002, 2004, 2006	**1992**
Mineral Fork	Washington	14	1994, 1998	--	2001-02	**2000**
Osage Fork of the Gasconade River	Laclede	36	1998-99	1998-99, 2001-05, 2007	2001-05, 2007	**2000**
Ten Mile Creek	Carter/Butler	14	1994, 1996-99	--	2000-03, 2005-06	**1999**

1 = Brown's Ford Access to Mammoth Access

2 = Big River confluence with Meramec River to Washington State Park (Hwy. 21), excluding Brown's Ford Access to Mammoth Access

3 = Washington State Park (Hwy. 21) to Leadwood Access

Electrofishing Surveys

Control areas, pre-regulation SBBSMA (pre-SBBSMA) and post-regulation SBBSMA (post-SBBSMA) electrofishing data were gathered up to 11 years before and 16 years after implementation of special regulations at SBBSMAs (Table 1). However, a low number of samples during some years limited reporting to a total of 14 years (up to six years prior and eight years after implementation of special regulations). Control area data (under statewide regulations) were summarized for Big River, Big Piney River, James River, Meramec River and Osage Fork of the Gasconade River; however, no evaluation occurred for more than two years prior to implementation of special regulations. Pre- and post-SBBSMA data were summarized for 12 sections on 10 streams for a total of 14 years (Table 1); however, six SBBSMAs featured pre-regulation evaluations of less than two years.

Post-SBBSMA electrofishing surveys showed modest increases in average smallmouth bass catch and most size structure indices over pre-SBBSMA data. Average smallmouth bass electrofishing catch per mile and catch per hour exhibited similar trends; modest stock-size increases followed by significant increases in 12 to 15-inch catch and lesser increases for fish ≥ 15 inches (Table 2).

Table 2. Catch per mile and catch per hour for stock-sized, 12 to 15-inch, ≥ 15-inch and ≥ 18-inch, Proportional Stock Density (PSD) and Relative Stock Densities (RSD) for smallmouth bass from all SBBSMA before and after implementation of special regulations, 1990-2007.

ALL SBBSMAs	Catch/mile Stock-sized	Catch/hour Stock-sized	Catch/mile 12-15"	Catch/hour 12-15"	Catch/mile ≥15"	Catch/hour ≥15"	Catch/mile ≥18"	Catch/hour ≥18"	PSD	RSD12	RSD15	RSD18
Pre-SBBSMA	40.25	30.55	8.63	5.61	2.68	1.82	0.25	0.16	37.9%	25.2%	5.7%	0.7%
SBBSMA	44.08	32.92	10.77	7.95	3.02	2.39	0.31	0.19	42.8%	30.6%	6.9%	0.5%
% Change	**+ 9.5%**	**+7.8%**	**+24.8%**	**+41.7%**	**+12.7%**	**+31.3%**	**+25.5%**	**+21.8%**	**+12.8%**	**+21.7%**	**+22%**	**-26%**

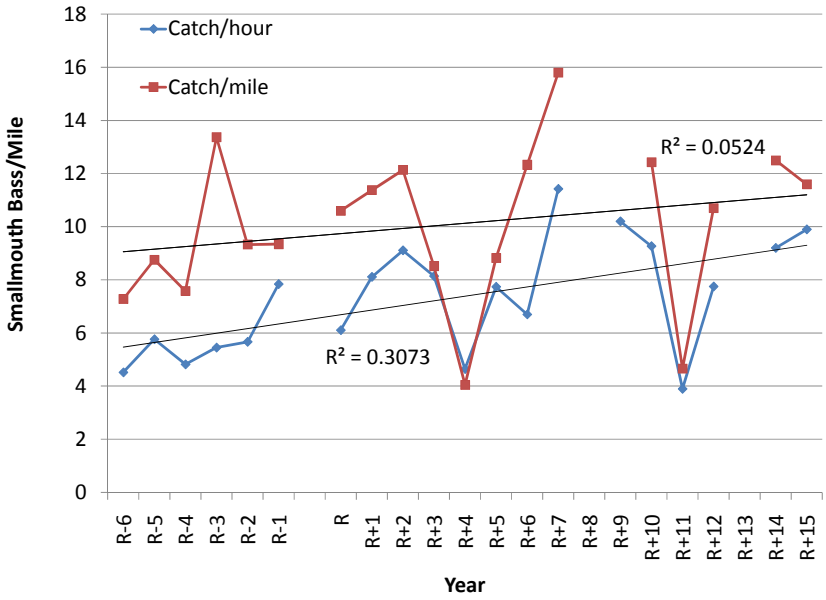
***Terminology tip**: Fisheries biologists use a parameter called proportional stock density (PSD) which refers to the percent of smallmouth bass collected which are at least 7 inches long (stock size) that are also greater than or equal to 11 inches. In Missouri, a very common size of interest is the statewide minimum length limit of 12 inches or the 15-inch mll. In general, fish smaller than the stock size are hard to collect and including them in percentage calculations could add a lot of unpredictable variability to the percentages.*

***Terminology tip**: Fisheries biologists use a parameter called relative stock density (RSD_{12}, RSD_{15} or RSD_{18}) which refers to the percent of smallmouth bass collected which are at least 7 inches long (stock size) that are also greater than or equal to 12, 15 or 18 inches. In Missouri, a very common size of interest is the minimum length limit of 15 inches for these high-quality fisheries. In general, fish smaller than the stock size are hard to collect and including them in percentage calculations could add a lot of unpredictable variability to the percentages.*

Eighteen-inch smallmouth bass average catch per mile and catch per hour increased by 25.5% and 21.8%, respectively (Table 2). Average catch per hour increases for 12 to 15-inch and ≥15-inch smallmouth bass were 41.7% and 31.3%, respectively. Average catch per mile increases for 12 to 15-inch and ≥15-inch smallmouth bass were 24.8% and 12.7%, respectively. Average yearly catch data exhibited considerable variability, especially those related to stock-sized smallmouth bass (Appendix 2).

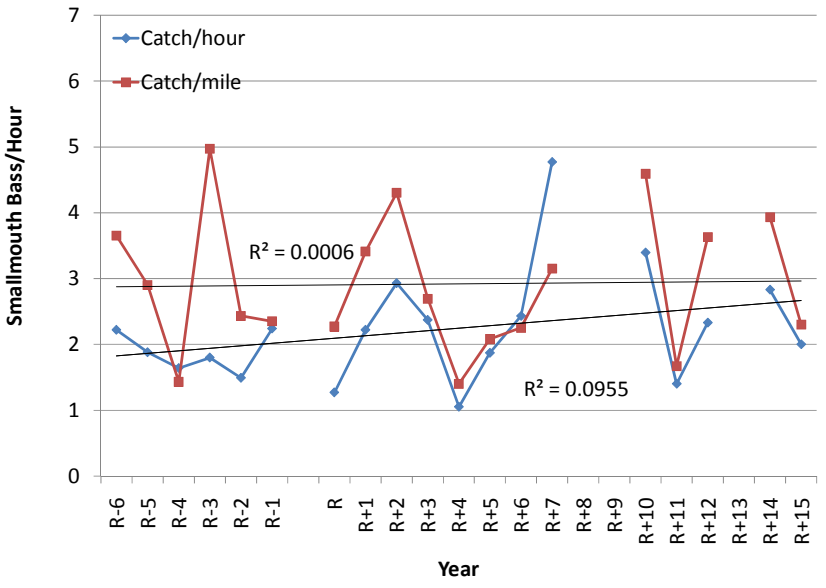
In addition to modest gains in average electrofishing catch per mile and catch per hour, overall trends show increasing gains of 12 to 15-inch smallmouth bass over time (Figure 2). Smallmouth bass average catch per hour and catch per mile for ≥15-inch fish was variable, but catch per hour trended somewhat upward six years after implementation of special regulations and beyond (Figure 3). Stock-sized and ≥18-inch smallmouth bass catch was variable.

Figure 2. SBBSMA 12 to 15” smallmouth bass electrofishing catch per hour and catch per mile, before and after implementation of 15” minimum length limit and daily limit of one regulation (R).



R = Year of special regulation implementation

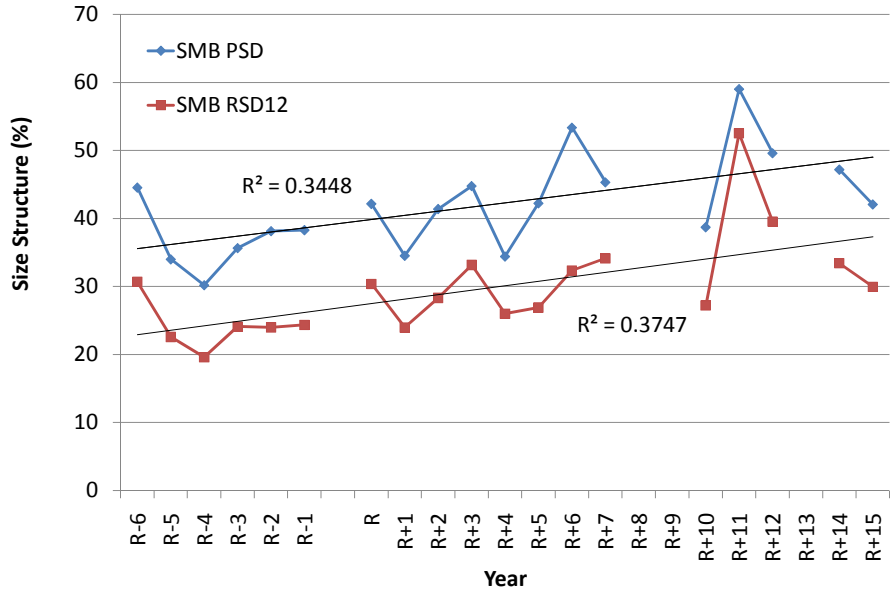
Figure 3. SBBSMA ≥ 15”smallmouth bass electrofishing catch per hour and catch per mile, before and after implementation of 15” minimum length limit and daily limit of one regulation (R).



R = Year of special regulation implementation

With the exception of RSD18, average smallmouth bass size structure improved after implementation of special regulations (Table 2). Average size structure increases correspond with those for average electrofishing catch of stock-sized, 12 to 15-inch and ≥15-inch smallmouth bass. Average RSD18 dropped 26% despite increases in average catch per mile and catch per hour of 18-inch smallmouth bass, but probably demonstrates the impact of increased numbers of 12 to 17.9-inch smallmouth bass. Average PSD, RSD12 and RSD 15 trended upward throughout post-SBBSMA evaluation, while RSD18 showed little change (Figures 4 and 5).

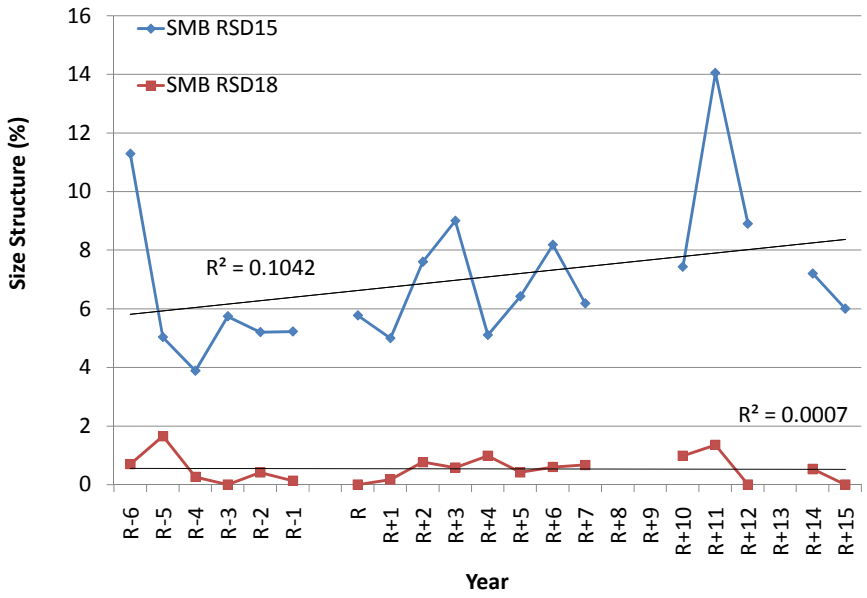
Figure 4. SBBSMA smallmouth bass PSD and RSD12 from electrofishing, before and after implementation of 15" minimum length limit and daily limit of one regulation (R).



R = Year of special regulation implementation

Average electrofishing survey data for Big, Big Piney, James, Meramec and Osage Fork rivers' control areas and post-SBBSMA showed some similarities to pre-and post-SBBSMA comparisons from all SBBSMAs, but was inconsistent for indices relating to smallmouth bass larger than 15 inches (Table 3). Post-SBBSMA stock-sized smallmouth bass average catch per mile and catch per hour increased over control areas for the five streams by 17.4% and 16.6%, respectively (Table 3). However, post-SBBSMA 12 to 15-inch smallmouth bass average catch data was mixed; as catch per mile increased by 37.7% and catch per hour was unchanged compared to control area results. Greater than or equal to 15-inch and 18-inch smallmouth bass post-SBBSMA average electrofishing catches were 9.7% to 63% lower, respectively, than control area results.

Figure 5. SBBSMA smallmouth bass RSD15 and RSD18 from electrofishing before and after implementation of 15” minimum length limit and daily limit of one regulation (R).



R = Year of special regulation implementation

Table 3. Average electrofishing catches, Proportional Stock Density (PSD) and Relative Stock Densities (RSD) for smallmouth bass from Big, Big Piney, James, Meramec and Osage Fork of the Gasconade rivers’ control areas and post-regulation (SBBSMA) areas, 1990-2007.

Big, Big Piney, James, Meramec and Osage Fork Rivers	Catch/mile Stock-sized	Catch/hour Stock-sized	Catch/mile 12-15”	Catch/hour 12-15”	Catch/mile ≥15”	Catch/hour ≥15”	Catch/mile ≥18”	Catch/hour ≥18”	PSD	RSD12	RSD15	RSD18
Control Areas	29.59	23.81	5.46	6.39	2.48	2.81	0.33	0.23	37.8%	27.2%	8.6%	1%
Post- SBBSMA	34.73	27.76	7.52	6.39	2.24	1.99	0.16	0.2	40.9%	28.5%	6.6%	0.6%
% Change	**+17.4%**	**+16.6%**	**+37.7**	--	**-9.7%**	**-29.2%**	**-63%**	**-13%**	**+7.9%**	**+4.8%**	**-23%**	**-44%**

Post-SBBSMA average size structure improved for smaller smallmouth bass, but declined for larger fish. PSD and RSD12 increased by 7.9% and 4.8% over control areas, while average RSD15 and RSD18 dropped by 23.2% and 44.2%, respectively.

Big, Big Piney, James, Meramec and Osage Fork of the Gasconade rivers’ post-SBBSMA data showed strong increases over pre-SBBSMA for all indices except for ≥18-inch electrofishing catch (Table 4). Electrofishing catch of 12 to 15-inch and ≥15-inch smallmouth bass increased by over 55% and 37%, respectively. Catch per mile increases were larger. These increases were similar but more pronounced than comparisons between all pre- and post-SBBSMA, especially six years after implementation of special regulations and beyond.

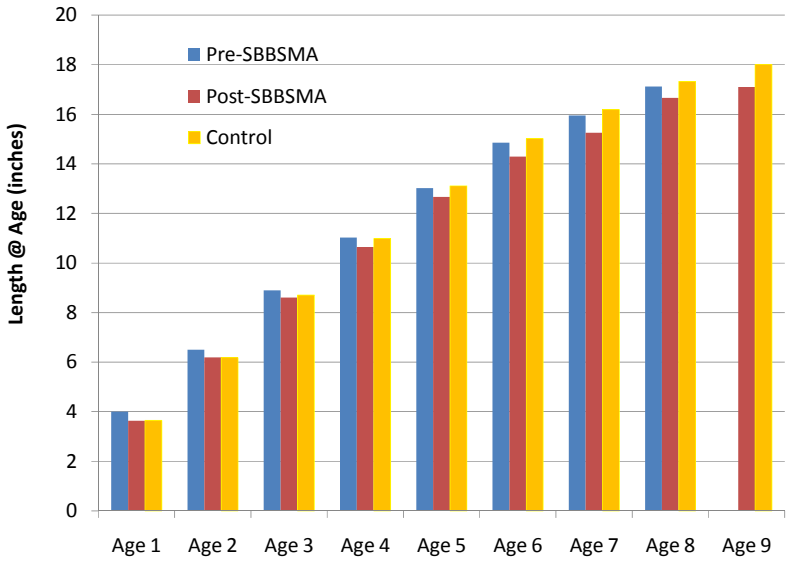
Table 4. Average smallmouth bass electrofishing catches, Proportional Stock Density (PSD) and Relative Stock Densities (RSD) from Big, Big Piney, James, Meramec and Osage Fork rivers' SBBSMA before and after implementation of special regulations, 1990-2007.

Big, Big Piney, James, Meramec and Osage Fork Rivers	Catch/mile Stock-sized	Catch/hour Stock-sized	Catch/mile 12-15"	Catch/hour 12-15"	Catch/mile ≥15"	Catch/hour ≥15"	Catch/mile ≥18"	Catch/hour ≥18"	PSD	RSD12	RSD15	RSD18
Pre-SBBSMA	28.92	22.22	4.84	3.91	1.64	1.05	0.42	0.25	35.2%	22.3%	5.1%	1.3%
Post-SBBSMA	34.73	27.76	7.52	6.39	2.24	1.99	0.16	0.2	40.9%	28.5%	6.6%	0.6%
% Change	**+20%**	**+25%**	**+55%**	**+63%**	**+37%**	**+89%**	**-163%**	**-25%**	**+16%**	**+28%**	**+29%**	**-116%**

Research evaluations on the Jacks Fork and Gasconade rivers found some increase in densities of stock-sized smallmouth bass on regulated portions of the Jacks Fork and Gasconade rivers, but size structure improved only on the Gasconade (Kruse and DeiSanti 2002). Densities of 15 and 18-inch or greater smallmouth bass showed little or no improvement on the Jacks Fork, while the Gasconade showed some progress during the last three years of the ten-year study.

Smallmouth bass growth declined slightly in SBBSMAs after implementation of special regulations (Figure 6). Except for age 2 smallmouth bass, control area and pre-SBBSMA average lengths at age outperformed those of post-SBBSMA by 0.01- to 0.93-inch. Differences in growth were more pronounced for older fish.

Figure 6. Average smallmouth bass length at age before and after implementation of special regulations at Big, Big Piney, James, Meramec and Osage Fork of the Gasconade rivers' control areas and regulation (SBBSMA) areas, 1990-2007.



Similar results were apparent when comparing statewide averages found by Purkett (1958) to SBBSMA and control areas (Table 5). Age 1 and 6 post-SBBSMA lengths at age were similar to statewide averages, but other years were somewhat slower.

Kruse and Deisanti (2002) found little difference in growth rates between Jacks Fork and Gasconade rivers' regulations and control areas. However, mean lengths at age were slightly lower in the Gasconade River regulation area compared to the control area.

Table 5. Average smallmouth bass length at age for statewide streams and Big, Big Piney, James, Meramec and Osage Fork of the Gasconade rivers' control areas, pre- and post-regulation (SBBSMA) areas.

	Age 1	**Age 2**	**Age 3**	**Age 4**	**Age 5**	**Age 6**
Purkett (1958)	3.5	6.7	9.6	11.4	13.5	14.6
Big, Big Piney, Meramec and Osage Fork rivers control areas (1986-2007)	3.7	6.2	8.7	11.0	13.1	15.0
Pre-SBBSMA (1990-2003)	4.0	6.5	8.9	11.0	13.0	14.9
Post-SBBSMA (1992-2007)	3.6	6.2	8.6	10.6	12.7	14.3

Angler Surveys

Big, Big Piney and Meramec rivers' control areas and SBBSMAs were evaluated with weekly probability, access point angler surveys during 1991-1996. Survey clerks interviewed anglers as they completed their fishing trips at boat launches and other access points. SBBSMA were established during 1992, so only one year of data (1991) was collected prior to implementation of special regulations. Harvest rate information could not be obtained from 1991, so no comparison of smallmouth bass harvest can be made. In addition, sublegal catch rate information was unavailable for 1991.

SBBSMA angler effort dropped immediately after implementation of special regulations and remained low during 1991-96 surveys, led by the Meramec River. SBBSMA average total fishing effort and trips dropped by 54% and 63%, respectively (Table 6). Meramec River total fishing effort and trips dropped by 536% and 459%, respectively. During that same time period, average decreases in Big and Big Piney rivers' total fishing effort and trips were only 28% and 16%, respectively. Control area total fishing effort and trips also dropped after implementation of special regulations and did not recover. Average trip length remained relatively unchanged at five hours.

Kruse and Deisanti (2002) found some evidence of angler effort declining in the Jacks Fork River regulation area after implementation of special regulations. However, control area effort remained unchanged. They also found Gasconade River angler effort was variable.

Table 6. Angler effort, smallmouth bass catch and smallmouth bass catch rates from angler surveys on the Big, Big Piney and Meramec rivers' SBBSMAs, 1991-1996.

	Average Total Angling Effort (hrs)	Average Black Bass Angling Effort (Hrs)	Average Total Angler Trips	Average Total SMB Catch	Average 12-15" SMB/mile	Average ≥15" SMB/mile	Average ≥18" SMB/mile	Average Legal SMB Catch Rate (≥15")	Average Total SMB Catch Rate
1991 (Pre-Regulation)	**15,502**	**5,861**	**4,219**	**3,843**	**581**	**51.8**	**13.8**	**0.0062**	**0.271**
1992+	9,108	4,983	2,227	6,204	681	75.0	32.9	0.0363	1.245
1993	7,083	4,472	1,495	3,855	557	64.8	4.4	0.0173	0.946
1994	6,555	3,700	1,378	5,055	1,399	83.5	23.2	0.0237	1.148
1995	6,087	3,608	1,405	4,327	1,006	104	22.7	0.054	1.762
1996	6,945	4,406	1,337	3,838	1,330	157	9.9	0.038	1.239
Post-Regulation SBBSMA Average	**7,156 (-54%)**	**4,234 (-28%)**	**1,568 (-63%)**	**4,656 (+21%)**	**995 (+71%)**	**96.9 (+87%)**	**18.6 (+35%)**	**0.0339 (+446%)**	**1.268 (+368%)**
+ = special regulations implemented									

SBBSMA average bass fishing effort showed a downward trend during the survey, but was heavily influenced by the Meramec River. Bass effort dropped by an average of 39% after implementation of special regulations (Table 6). However, if Meramec River bass fishing effort was removed, the Big and Big Piney rivers' average actually showed an 11% increase. Though control area average bass fishing effort increased by 150% immediately after the 1992 implementation of special regulations in the adjacent SBBSMAs, it dropped back to pre-1992 levels in 1993 and was variable thereafter (Table 7).

During 1991-96, SBBSMA angler surveys showed increases in numbers of smallmouth bass caught, average size caught and catch rate after implementation of special regulations (Table 6). During the same period, adjacent control area data exhibited decreases or were variable (Table 7).

Estimated smallmouth bass angler catch per mile increased for 12 to 15-inch, ≥15-inch and ≥ 18-inch in SBBSMAs after implementation of special regulations, while control area estimates declined. SBBSMA smallmouth bass catch per mile increased by averages of 71%, 87% and 35% for 12 to 15-inch, ≥15-inch and ≥18-inch smallmouth bass, respectively (Table 6). SBBSMA total smallmouth bass estimated angler catch increased by an average of 21%.

Table 7. Angler effort, smallmouth bass catch and smallmouth bass catch rates from angler surveys on the Big, Big Piney and Meramec rivers' control areas, 1991-1996.

	Average Total Angling Effort (hrs)	Average Black Bass Angling Effort (Hrs)	Average Total Angler Trips	Average Total SMB Catch	Average 12-15" SMB/mile	Average ≥15" SMB/mile	Average ≥18" SMB/mile	Average Legal SMB Catch Rate (≥12")	Average Total SMB Catch Rate
1991	**4117**	**1347**	**584**	**1347**	**254**	**54.1**	**7.05**	**0.124**	**0.531**
1992+	6153	3364	1855	2097	257	22.8	2.48	0.085	0.436
1993	2969	1065	918	1702	219	30.0	5.34	0.162	0.301
1994	2646	1584	652	1463	248	28.8	4.92	0.114	0.725
1995	1718	971	453	755	161	23.9	2.63	0.147	0.362
1996	1721	1003	406	685	159	11.9	2.61	0.125	0.444
+ = special regulations implemented in adjacent SBBSMA									

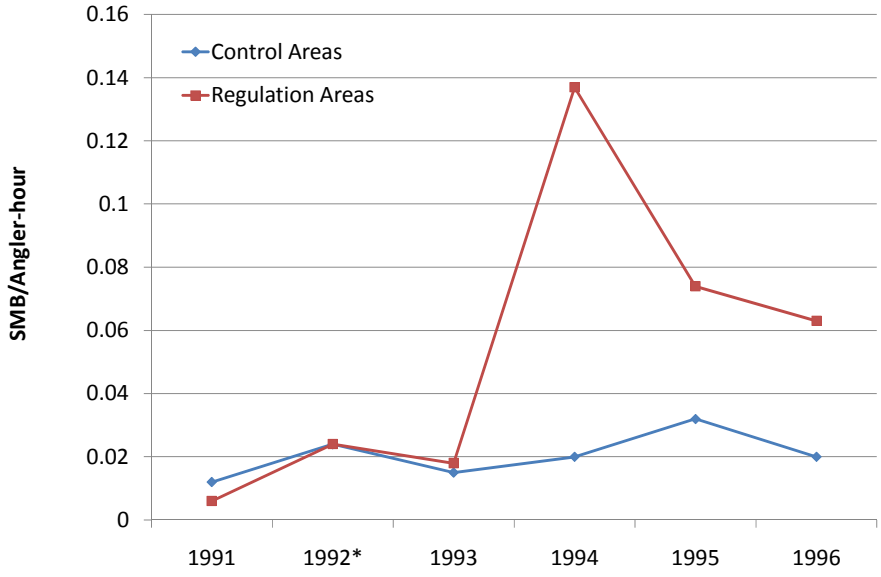
Though angler catch of 18-inch or larger smallmouth bass was somewhat variable, catch of 12 to 15-inch and ≥15-inch fish increased throughout the survey period after implementation of special regulations; however, significant increases began to occur during Year 3. In the third year, 12 to 15-inch smallmouth bass angler catch increased to 141% greater than pre-SBBSMA and remained high through the end of the survey (Figure 7). Following initial modest increases, ≥15-inch smallmouth bass angler catch increased by 101% during year four of special regulations (Figure 8) and continued to increase through the end of evaluation. Post-SBBSMA catch of 18-inch or larger smallmouth bass was generally greater than pre-SBBSMA and control areas; however, it was variable (Figure 9). These trends were especially true for the Big and Big Piney rivers, as Meramec River smallmouth bass catches actually dropped throughout the survey period.

Control area average estimated smallmouth bass angler catches per mile were somewhat variable, but decreased dramatically for all sizes and total catch (Table 7). Average 12 to 15-inch smallmouth bass catch slowly sagged after 1992, eventually dropping a total 37% by 1996. Average catch of ≥15-inch and ≥18-inch smallmouth bass decreased in 1992 and by 1996 had dropped by 78% and 63%, respectively. Total catch was actually highest in 1992 when special regulations were implemented adjacent to control areas, then steadily dropped well below 1991 values.

Legal and total smallmouth bass catch rates increased dramatically in SBBSMAs after implementation of special regulations (Table 6). Catch rate of legal-sized (≥15-inch) smallmouth bass jumped by 485% the year after implementation and was then somewhat variable, but well above the pre-regulation catch rate.

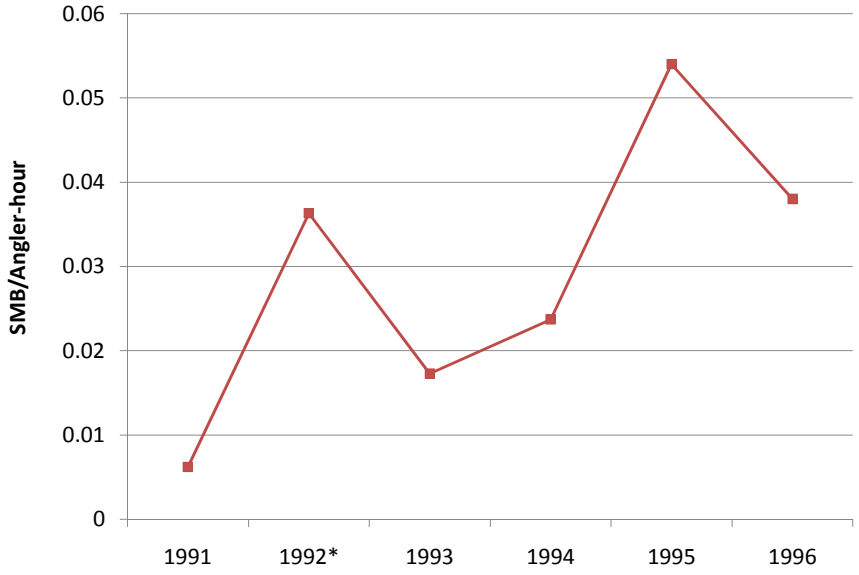
Total catch rate was similar with an average increase of 368%. Control area catch rates were variable, but remained essentially unchanged (Table 7).

Figure 7. Average 12-14.9" smallmouth bass angling catch rate at Big, Big Piney and Meramec rivers' control and regulation (SBBSMA) areas, 1991-1996.



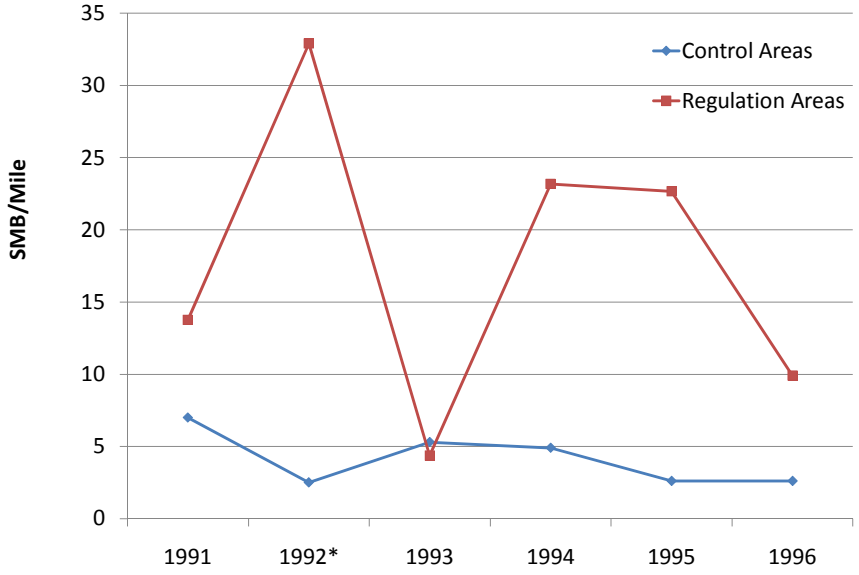
*** = Implementation of special smallmouth bass regulations; 15" mll, daily limit = 1**

Figure 8. Average ≥15" smallmouth bass angler catch rate at Big, Big Piney and Meramec rivers' SBBSMAs, 1991-1996.



*** = Implementation of special smallmouth bass regulations; 15" mll, daily limit = 1**

Figure 9. Average estimated angler catch of ≥ 18" smallmouth bass at Big, Big Piney and Meramec rivers' control and regulation (SBBSMA) areas, 1991-1996.

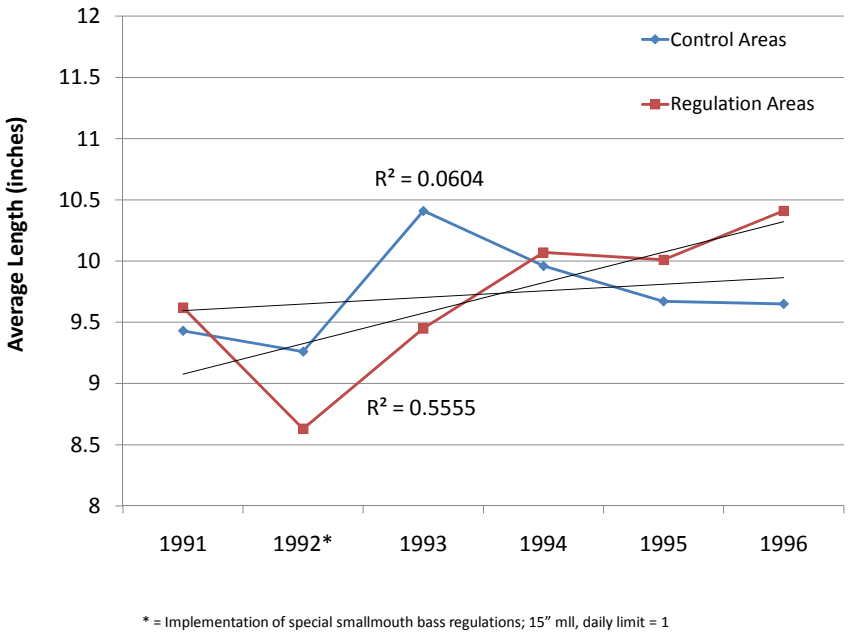


*** = Implementation of special smallmouth bass regulations; 15" mll, daily limit = 1**

Kruse and Deisanti (2002) found total angler catch of smallmouth bass declined in the regulation area of the Jacks Fork River, but remained stable in the control area. Gasconade River catch was mostly variable, but sub-legal catch may have increased in the final three years of the study. They also found some increase in smallmouth bass catch over 12 inches in the Jacks Fork River's regulation area and reported anglers catching larger smallmouth bass in the Gasconade River's regulation area during the final two years of the study.

Angler surveys showed the average size of smallmouth bass caught increased during most years in SBBSMAs after special regulations implementation, but was variable in control areas which remained under statewide regulations (Figure 10; Table 8).

Figure 10. Average length of angler caught smallmouth bass at Big, Big Piney and Meramec rivers' control and regulation (SBBSMA) areas, 1991-96.



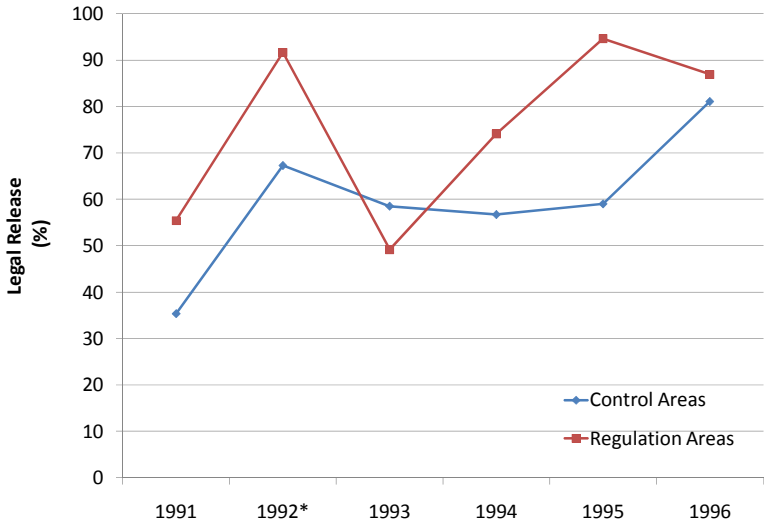
* = Implementation of special smallmouth bass regulations; 15" mll, daily limit = 1

Table 8. Average length of angler caught smallmouth bass at Big, Big Piney and Meramec rivers' control and regulation (SBBSMA) areas, 1991-96.

Location	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
Control Area	9.43"	9.05"	10.54"	10.14"	9.85"	9.73"
SBBSMA	9.62"	8.67"	9.42"	10.06"	10.02"	10.39"

Release of legal SBBSMA smallmouth bass averaged 55% before (12-inch mll) and 84.5% (15-inch mll) after implementation of special regulations. With the exception of 1993, legal release percentage increased throughout the evaluation period (Figure 11). Control area legal release averaged 60% during the same period, similar to pre-regulation SBBSMA data. However, control area legal release increased sharply in 1992 and again in 1996 (Figure 11). SBBSMA illegal harvest was similar to control areas and very low, averaging less than 1% for 1991-96.

Figure 11. Legal release (%) of smallmouth bass caught by anglers at Big, Big Piney and Meramec rivers' control and regulation (SBBSMA) areas, 1991-1996.



*** = Implementation of special smallmouth bass regulations; 15" mll, daily limit = 1**

Prior to implementation of a special 18-inch mll regulation on the Jacks Fork and Gasconade rivers, tag return and angler survey results showed anglers released more than half of the legal-sized (≥ 12") smallmouth bass caught (Kruse and Deisanti 2002). After regulation implementation, legal bass harvest could not be documented from tag returns or angler surveys. During 1991 in Courtois Creek, angler survey results showed over 90% of legal smallmouth bass caught by anglers were released (Smith 1992).

Angler attitudes toward SBBSMAs and special regulations ranged from indifferent to mildly supportive during the 1991-96 Big River angler survey. Prior to implementation of special regulations, most Big River anglers felt statewide stream black bass regulations had little impact on their fishing enjoyment, with 77% indicating it had no effect. Within the SBBSMA, only 26% of anglers felt statewide regulations added to their fishing enjoyment.

During 1993-95, 85% of Big River SBBSMA and control area anglers said Big River special regulations did not impact their fishing frequency; only 8% of SBBSMA and 14% of control area anglers reported fishing more often. However, an increasing percentage of bass preference anglers said they fished more often, from 16% (1992) to 36% (1995). Despite relatively low special regulation support overall, 38% of SBBSMA and 46% of control area anglers felt special regulations improved smallmouth fishing on Big River, led by bass preference anglers (50%). Anglers supported special regulation expansion on Big River by a 2:1 margin. Bass preference angler support for expansion was highest at 65%.

Kruse and Deisanti (2002) found mixed support for special regulations as Jacks Fork River anglers were indifferent and Gasconade River anglers were increasingly supportive after initial indifference.

Big River anglers exhibited some divergent opinions when asked to consider catch-and-release regulations. In 1993-1995, all anglers were asked, "If smallmouth bass regulations on Big River were changed to catch-and-release only, making it illegal to keep any smallmouth bass, would you fish Big River more, less or about the same?" The majority of anglers answered "about the same." Forty-five percent of SBBSMA and 15% of control area anglers said they would fish more. Surprisingly, only 18% of bass preference anglers said they would fish more. SBBSMA and control area anglers indicating they would fish less averaged 20%.

Zip code analysis of Big River anglers demonstrated a highly-localized fishing user base. During 1991-96, approximately 70% of anglers fishing the Big River SBBSMA resided in Jefferson County. Number of fishing trips followed a similar trend with the majority of these anglers residing in the Jefferson County cities of DeSoto and Hillsboro which are located within 15 miles of the Big River SBBSMA. St. Louis City and County residents made up 19% of Big River SBBSMA anglers.

Kruse and Deisanti (2002) found non-local Jacks Fork and Gasconade River anglers fished for a wider variety of reasons than local anglers who fished primarily because it was close to home. Some anglers felt implementation of special regulations increased their chances of catching larger smallmouth bass, which increasingly became an important reason to fish areas with more restrictive regulation. This was especially true for non-local anglers fishing the Gasconade River.

Angler affiliation with angling clubs was measured during the Meramec River angler survey. Over 90% of anglers said they were not members of any angling clubs. Fewer than 4% said they belonged to B.A.S.S. or the Missouri Smallmouth Bass Alliance.

Black bass identification was tested during the 1993-96 Big River angler surveys. About 80% of all anglers correctly identified largemouth and smallmouth bass, while only 44% correctly identified spotted bass. The majority of answers grouped into the "other" category were generically called "bass" by anglers.

Exploitation

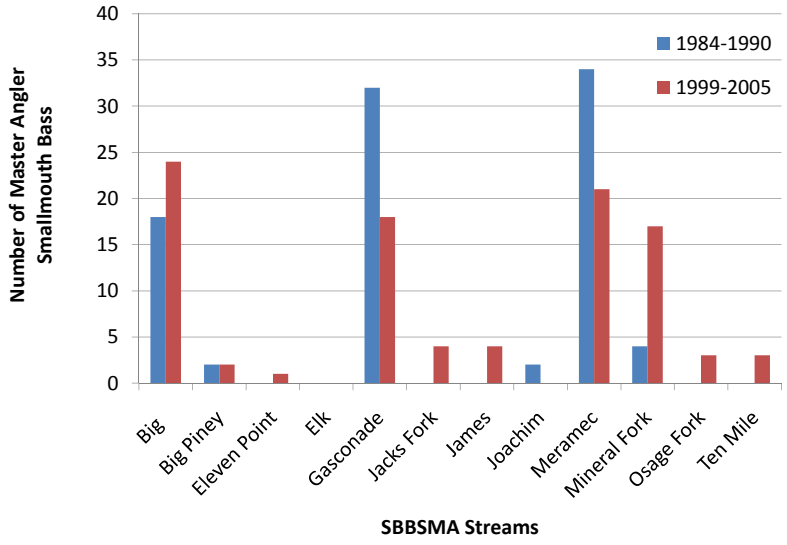
Tag returns showed relatively low angler exploitation and suggest significant legal release of smallmouth bass. Big River anglers returned 13 of 47 (28%) and 97 of 675 (14%) of non-reward tags affixed to smallmouth bass $\geq$12 inches, prior to and after implementation of special regulations, respectively. Correcting for non-reporting, the exploitation rate after regulation implementation was 24.6%.

Similar results were found for the Jacks Fork and Gasconade rivers' smallmouth bass tagged with reward tags (Kruse and Deisanti 2002). Anglers returned 8 to 35% of Jacks Fork and 25 to 45% of Gasconade River smallmouth bass tags during 1991-2001. In 1995-96 on the Bourbeuse River, anglers returned 22% of tagged smallmouth bass (Smith 1998). Legal ($\geq$ 12") smallmouth bass harvest was estimated to be 7% and 8% in 1995 and 1996, respectively.

Master-Angler

Numbers of Master Angler-sized smallmouth bass reported by anglers in SBBSMA streams were compared during two, six-year stretches before (1984-1990) and after (1999-2005) implementation of special regulations (Figure 12). Since the minimum Master Angler size for smallmouth bass increased from 17 to 18 inches in 2006, the time interval of 1999-2005 was chosen for the most recent post-SBBSMA regulation data set.

Figure 12. SBBSMA smallmouth bass reported to the Master Angler Program by anglers before and after implementation of special regulations, 1984-1990 and 1999-2005.



Seven of twelve streams containing an SBBSMA showed an increase in numbers of Master Angler smallmouth bass reported after implementation of special regulations, while three showed a decrease. Of the 27 streams listed in the 1999-2005 Master Angler List, 10 contained an SBBSMA which boasted 49% of all qualifying smallmouth bass reported. Big River and Mineral Fork exhibited largest increases of 25% and 76%, respectively. Gasconade and Meramec rivers decreases were greatest at 44% and 48%, respectively. Overall, the total number of Master Angler smallmouth bass reported from SBBSMA streams increased by five percent after special regulations were implemented.

DISCUSSION

During 1990-2007, evaluations were completed for twelve SBBSMAs under special regulations (Table 1). Increases in smallmouth bass catch rates, size structure and angler catch were observed in most evaluations. However, increases were less than stated objectives (Table 9). In addition, angler effort significantly decreased.

Table 9. Smallmouth bass fishery management objectives and electrofishing and angler survey results for twelve SBBSMA evaluations, 1990-2007.

OBJECTIVES	Electrofishing Surveys	Angler Surveys
Double (100%) 12-14.9” smallmouth bass	No; only 25%-42% increase	No; only 71% increase
Double (100%) 15”+ smallmouth bass	No; only 13%-31% increase	No; only 87% increase
Increase 18”+ smallmouth bass	Yes; 21%-25% increase	Yes; 35% increase
No decrease in angler effort	N/A	No; total angler effort decreased by 54% and bass preference effort decreased by 28%

Though differences in scale existed, electrofishing and angler surveys displayed similar results. Comparisons of pre-SBBSMA to post-SBBSMAs electrofishing data from all SBBSMA and angler survey comparisons between control areas and related SBBSMAs for Big, Big Piney, James, Meramec and Osage Fork rivers showed smallmouth bass numbers and size structure increased in SBBSMA after implementation of special regulations. In general, most control area smallmouth bass indices remained unchanged or decreased. Angler survey data showed greater increases and better defined trends than electrofishing data, underscoring their importance as an evaluation tool.

Heavily influenced by the Meramec River, fishing pressure and trips declined dramatically in control and SBBSMA areas. SBBSMA effort and trips dropped immediately after special regulations were implemented in 1992. Control area fishing pressure and trips initially increased (buoyed by an increase in bass preference anglers), but quickly reversed and followed a downward trend throughout the evaluation period. Very high flows for the Big and Meramec rivers in 1993 and 1995 may have had some impact, but that does not explain declines throughout the evaluation period. Bass preference angler effort also declined, but at about half the rate of total effort.

Post-SBBSMA angler survey and electrofishing results showed increases over control area and pre-SBBSMA for most indices. Post-SBBSMA angler catch of total, 12 to 15-inch, $\geq$15-inch and $\geq$18-inch smallmouth bass and angler total catch, and legal catch, and total catch rate all increased over control area and pre-SBBSMA. Post-SBBSMA electrofishing smallmouth bass catch of stocked-size, 12 to 15-inch, and $\geq$18-inch, PSD and RSD12 increased as well. Electrofishing catch of $\geq$15-inch smallmouth bass and RSD15 indices were mixed, while RSD18 and total angling effort, black bass angling effort and total angler trips were consistently lower for post-SBBSMA time periods.

In general, increases in numbers of 12 to 15-inch and ≥15-inch smallmouth bass indices occurred earlier and were more substantial than increases in stock-size and ≥18-inch indices. Angler survey data suggested that increased angler catch of larger smallmouth bass may not happen immediately after implementation of special regulations. Results showed increases in 12 to 15-inch and ≥15-inch smallmouth bass occurred three and four years after implementation, respectively. Electrofishing results showed a similar trend for 12 to 15-inch fish. However, increases in total smallmouth bass angler catch occurred the year following regulation implementation. Except for electrofishing catch of 12 to 15-inch smallmouth bass, no consistent increasing trends were seen for pre-SBBSMA results. Control areas showed only weak upward trends for electrofishing stock-sized and 12 to 15-inch smallmouth bass.

Electrofishing data revealed size structure improvements in SBBSMAs were slow, but steady. PSD, RSD12 and RSD15 improved within three years of special regulation establishment and continued throughout most of the evaluation. RSD 18 was variable. Control area size structure followed a weaker, but similar trend after implementation of special regulations. Pre-SBBSMA size structure was relatively unchanged. The average size of smallmouth bass caught by anglers steadily increased throughout the evaluation period in SBBSMA, while control area average size was variable, but lower the last two years.

Angler catch rates of smallmouth bass soared in SBBSMAs as fishing effort fell and numbers of fish increased. Dramatic increases in legal (greater than 15-inch) and total smallmouth bass angler catch provided evidence of positive change from implementation of special regulations. When coupled with unchanged angler catch rates in the control areas, the case is more compelling.

Smallmouth bass growth rates slowed slightly under special regulations. However, annual differences between pre-SBBSMA and control areas and SBBSMA were less than one (1) inch.

Seven of twelve streams containing a SBBSMA showed increases in numbers of Master Angler smallmouth bass reported after implementation of special regulations. Overall, the total number of Master Angler smallmouth bass reported from SBBSMA streams increased by 5%.

Voluntary release of legal smallmouth bass in angler surveys and Big River tag returns of ≥ 12" smallmouth bass suggest low exploitation rates before and during the evaluation period. Legal release in the control area and pre-SBBSMA was 36% and 55% before implementation of special regulations, respectively. Control area legal release trended upward after implementation of special regulations in the adjacent SBBSMA. Fewer than 30% of Big River smallmouth bass tags were returned, and of those only 32% of control/pre-regulation area and 11% of SBBSMA fish were harvested. Post-SBBSMA legal release was variable, but over 40% greater than control areas and pre-SBBSMAs.

Anglers were mostly indifferent toward implementation of special regulations and the impact of statewide regulations on their fishing. Only 8% of Big River SBBSMA and 14% of control area anglers reported fishing more often because of special regulations. However, 38% of SBBSMA and 46% of control area anglers felt special regulations improved smallmouth fishing on Big River. Hypothetical, mandatory catch-and-release regulations would be welcomed through increased fishing by 45% of Big River

SBBSMA and 15% of control area anglers, while 20% indicated they would not favor such a change and would fish less. Seventy-seven percent of Big River anglers felt statewide black bass regulations had no effect on their fishing enjoyment.

The majority of people fishing SBBSMAs may live nearby and be unaffiliated with any angling clubs. Zip code analysis indicated about 70% of Big River anglers resided in Jefferson County, with the majority living within 15 miles. Fewer than 20% resided in St. Louis City and County. In addition, over 90% of Meramec River anglers indicated they were not members of any angling clubs. Fewer than 4% reported they were members of B.A.S.S. or the Missouri Smallmouth Bass Alliance.

Some evaluation results mentioned above indicate full impacts of special regulations may not be known for many years, suggesting a need for more long-term monitoring. In addition, performance of SBBSMAs may have been impacted by below average rainfall and subsequent low flows. SBBSMA streams suffered drought conditions comparable to those experienced during the Great Dust Bowl (1930-36). SBBSMA stream discharges were below average at USGS gage stations during 68% of SBBSMA evaluation months, as compared to 79% of months during the Great Dust Bowl (Figure 13). Average monthly stream discharges were actually worse than the Great Dust Bowl during three months (Figure 14). Big River and Elk River data were not available during 1930-36; however, monthly discharge data during evaluations on these streams (1991-2008 and 1996-2008, respectively) were very similar to other SBBSMA streams.

Impacts of these drought conditions on smallmouth bass populations are unclear. However, biologists noted reduced available smallmouth bass habitat during low flows. Reduction in habitat can reduce available food and space leading to increased inter- and intra-species competition, potentially impacting smallmouth bass abundance, growth and size structure and potentially masking impacts of special regulations.

Figure 13. Monthly discharge (%) below long-term average for SBBSMA streams during the Great Dust Bowl (1930-36) and 1991-2008.

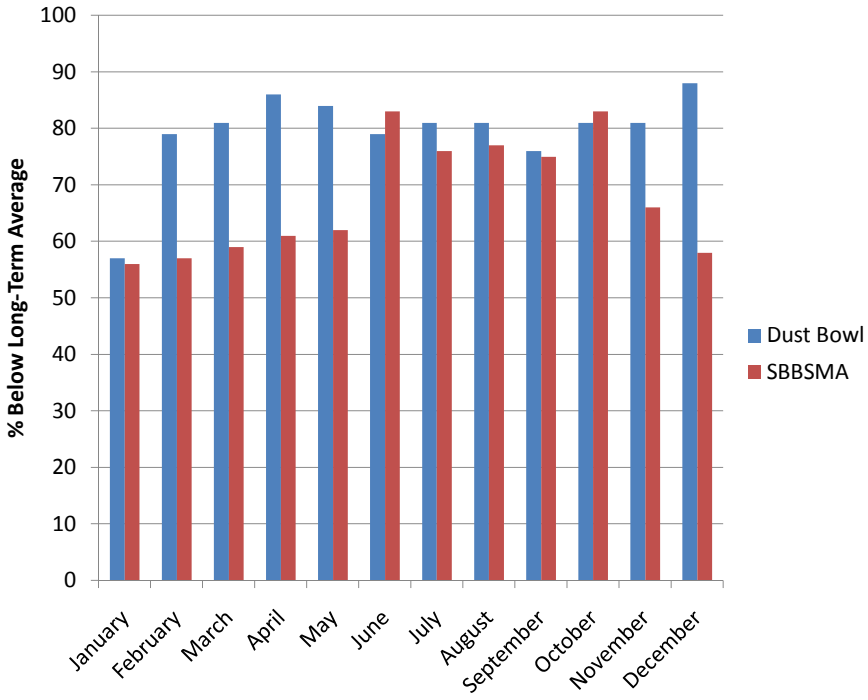
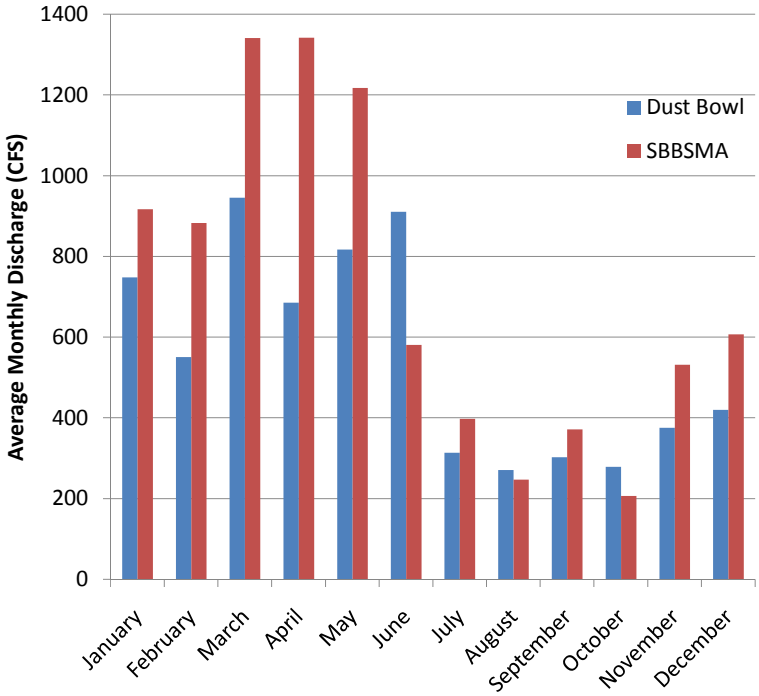


Figure 14. Average monthly discharge (CFS) for SBBSMA streams during the Great Dust Bowl (1930-36) and 1991-2008.



At the end of SBBSMA evaluation, SMBWG members were asked for their thoughts regarding Missouri smallmouth bass management in streams and lakes. The majority felt the Smallmouth Bass White Paper process met its objectives and addressed the most important stream resources. Special regulations were implemented where they were thought to provide the best benefits; however, special regulations were not deemed appropriate in all streams due to habitat, regulatory or other concerns or that existing regulations were already maximizing fishery potential.

However, some SMBWG members identified potential areas for improvement of managing Missouri's smallmouth fisheries. They included:

1. Improve regulatory support of special regulations.
2. Explore smallmouth bass angler use, attitudes and opinions.
3. Better understand smallmouth bass habitat and pro-actively target improvement projects.
4. Better understanding of special regulation impacts on smallmouth bass in small streams.
5. Consider change in smallmouth bass standardized sampling guidelines.
6. Consider a centralized and standardized long-term SBBSMA monitoring program.
7. Better understanding/appreciation and development of reservoir fisheries.

Poor regulatory support was cited during ten evaluations. In most cases, there were concerns over the probability of lenient penalties for special fishing regulation violations by county judges and prosecutors; thereby frustrating Protection Division efforts. Fisheries Division and Protection Division perceptions of rural angler acceptance of special regulations were also concerns. Angler desires for harvest and consumption of smallmouth bass from some streams remains significant.

Existing information about smallmouth bass angler use, perceptions and attitudes is highly localized and incomplete. Significant input from St. Louis angling clubs and Big, Big Piney and Meramec rivers' SBBSMA angler surveys provided very local information, but limited statewide applicability. Improved statewide understanding of smallmouth anglers would aid in MDC planning and prioritization efforts, as well as define angler interests in smallmouth management outcomes.

Missouri is fortunate to have hosted significant research describing and identifying habitat quality of Ozark streams. However, the full understanding of this work's potential impacts on statewide management of smallmouth bass is yet to be realized. A more complete understanding could lead to the pro-active identification of optimum smallmouth bass habitats and their locations, help identify local habitat shortcomings, focus on priority habitat improvements and help refine discussions about future SBBSMA needs, all making our best smallmouth bass streams better places for smallmouth bass.

Smallmouth populations showed little improvement in some smaller (< Order 6) streams, raising concerns over wadeable streams possibly not performing well under existing regulation choices. Only four SBBSMAs are located on smaller streams (Joachim Creek, Mineral Fork Creek, Osage Fork River and Tenmile Creek), all under 15-inch mll, daily limit of one special regulations. Only Mineral Fork Creek exhibited substantial smallmouth bass population improvements after implementation of special

regulations; the others exhibited variability and slowing growth rates for age 6 fish and older. Perhaps, additional study is needed to determine why smaller streams may underperform with 15-inch mll and daily limit of one regulations and what strategies might be better suited to maximize smallmouth bass potential in smaller streams.

Smallmouth bass sampling guidelines (Turner et. al. 1991) have served the effort well. However, implementation of smallmouth/otter protocols, field experimentation with new methods and use of new sampling equipment have led to potential biases when comparing survey results between streams. Experimental sampling using two electrofishing boats working in concert may improve sampling efficiency. This could improve mark and recapture results, as well as reduce some variability of catch per unit effort data. Sampling designed to improve the detection of size structure changes may include spring electrofishing. Use of a variety of electrofishing control boxes may introduce significant catch rate variability. Refining standardized sampling guidelines would help improve comparability of sampling results.

Long-term monitoring of priority smallmouth bass populations would help determine long-term impacts of habitat changes and special regulations on smallmouth fisheries. Long term monitoring coupled with centralized reporting might help improve our understanding of special regulation impacts during extended environmental changes, such as drought. Also, this information would increase effectiveness of the smallmouth bass coordinator and improve MDC's knowledge of its valuable smallmouth fisheries.

Finally, some felt that reservoir smallmouth bass fisheries should either receive more attention or credit. Most SBBSMAs are managed under a 15-inch mll regulation; however, the majority of large Missouri reservoirs are also under a 15-inch mll regulation. Smallmouth bass benefit from these regulations, but are not seen as special by some people. Perhaps these fisheries could be better promoted. A few biologists felt MDC either needed to learn more about reservoir smallmouth fisheries or could do more to emphasize them. In doing so, perhaps additional high-quality smallmouth fisheries could be developed or promoted. The White Paper effort did not address reservoir fisheries.

SUMMARY

Missouri's stream smallmouth bass populations are valuable, and stream smallmouth fishing continues to be popular. Past management efforts have ensured stable smallmouth bass populations and good fishing in many Missouri streams. In 2009, Missouri's SBBSMA total 358 miles of water on 12 streams (Figure 1). When Meramec River Basin spotted bass special regulations are included, the SBBSMA total jumps to 2,091 miles. In addition, smallmouth bass populations in upper Big River, Pomme de Terre River and lower Salt River are currently being evaluated for SBBSMA potential.

Implementation of special regulations in SBBSMAs has further improved some of Missouri's best black bass streams. However, the impacts of anglers, stream habitat quality and extended periods of low flows may delay or reduce expected results.

Smallmouth bass fishery management objectives for SBBSMAs called for a doubling of 12 to 15-inch and ≥15-inch smallmouth bass, with an increase in 18-inch or greater fish. The 18-inch smallmouth bass objective was met, but increases in catch rates of 12 to 15-inch and ≥15-inch smallmouth bass fell short of objectives. In addition, objectives to maintain pre-SBBSMA levels of fishing effort after special regulations were implemented were not achieved.

In addition to increases in smallmouth bass size structure and numbers, establishment of SBBSMAs provided several positive results. Anglers caught more and larger smallmouth more quickly than prior to regulation changes. Although smallmouth bass exploitation was already relatively low, release of legal fish within SBBSMAs increased. Growth rates were minimally affected. MDC placed significant emphasis on evaluating and managing Missouri's stream smallmouth fisheries and stream anglers became more aware of them.

Smallmouth bass populations managed under SBBSMA special regulations clearly performed better than those under statewide regulations in pre-SBBSMA and adjacent control areas. Through increases in numbers and sizes of smallmouth bass caught by anglers and angler catch rates, fishing quality improved as well. The observed improvement may, in part, reflect the selection of SBBSMA reaches that biologists believed represented the best chance for smallmouth bass population enhancement and success of the new regulations. Therefore, it cannot necessarily be assumed that smaller streams, streams with more limiting or marginal habitat or streams with a limited smallmouth bass population have the same potential for improvement or would yield similar results.

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Appendix 1. List of Smallmouth Bass White Paper candidate smallmouth bass study streams.

Stream	**County**	**Evaluation Begins**	**Projected Management Decision Date**	**Actual Management Decision Date**
Big River	Jefferson	1996	1998	1998
Mineral Fork	Washington	1996	1998	1998
Shoal Creek	Newton	1996	1998	1998
Tenmile Creek	Butler	1996	1998	1998
Osage Fork of the Gasconade River	Laclede	1996	1998	1998
Niangua River	Camden/Dallas/Laclede	1997	1999	2000
Eleven Point River	Oregon	1998	2000	2000
Glaize Creek	Camden	1998	2001	2002
Beaver Creek	Taney	1998	2001	2001
Big River	St. Francois	1998	2001	2002
Elk River	McDonald	1998	2001	2002
Flat Creek	Barry/Stone	1998	2001	2001
Little Niangua River	Camden	1998	2001	2002
Osage River	Cole/Miller/Osage	1998	2001	2002
Tavern Creek	Miller	1998	2001	2005
Black River	Reynolds	1999	2001	2002
Indian Creek	McDonald	1999	2001	2002
Meramec River	St. Louis	1999	2001	2001
Plattin Creek	Jefferson	1999	2001	2004
Big Creek	Iron/Wayne	2000	2001	2001
Gasconade River	Maries/Osage	1998	2003	2003
Meramec River	Franklin	1998	2003	2003
Huzzah Creek	Crawford	1998	2003	2004
Cole Camp Creek	Benton	2000	2003	2003
Joachim Creek	Jefferson	2000	2003	2005
Weaubleau Creek	St. Clair	2000	2003	2001
Saline Creek	Perry/Ste. Genevieve	2002	2003	2002
West Fork of Black River	Reynolds	2002	2003	2002
Pomme de Terre River	Hickory	2001	2004	In-process of re-evaluation
Gravois Creek	Morgan	2001	2004	2006
Finley Creek	Christian	2002	2005	2005
Castor River	Bollinger/Madison	2004	2006	2006
Crooked Creek	Bollinger	2007	2008	2004
Whitewater River	Bollinger/Cape Girardeau	2009	2011	2004
River Aux Vases	Ste. Genevieve	2012	2013	2004
Apple Creek	Cape/Girardeau/Perry	2014	2015	2004

Appendix 2 Electrofishing catches and size structure for pre- and post-SBBSMA smallmouth bass, 1990-2007.

Post-SBBSMA		Stream	Effort		Catch	Rate	FISH/MILE		Catch	Rate	FISH/HOUR					
Stream	**Year**	**Miles**	**(Hours)**	**N**	**≥7"**	**12-15"**	**≥15"**	**≥18"**	**≥7"**	**12-15"**	**≥15"**	**≥18"**	**PSD**	**RSD12**	**RSD15**	**RSD18**
Big River	R	1.19	2.05	99	63	9.2	2.50	0	36.6	5.4	1.46	0	29	18.7	4	0
Big River-Upper	R	2.23	2.6	52	15.7	3.1	1.80	0	13.5	2.7	1.5	0	45.7	31.4	11.4	0
Big River-Reed	R	8.5	11.3	299	26.2	4.7	0.90	0	19.7	3.5	0.7	0	34	21	4	0
Big Piney	R	4.2	3.7	89	32.6	9.3	1.20	0	18.7	6.5	1.1	0	48	41	6	0
Eleven Point River	R	1.71	2.9	122	67.3	20.5	2.30	0	39.7	12	1	0	51	34	3	0
Meramec River	R	10.2	11.3	291	19	2.4	0.20	0	17.5	2.1	0.2	0	27.3	13.4	1	0
Tenmile Creek	R	1.3	3.1	109	61	25	7.00	0	26	10.6	2.9	0	60	53	11	0
	R total	**29.33**	**36.95**	**1061**												
	R ave	**4.19**	**5.28**	**158.67**	**40.69**	**10.60**	**2.27**	**0.00**	**24.53**	**6.11**	**1.27**	**0.00**	**42.14**	**30.36**	**5.77**	**0.00**
Big River	R+1	1.01	1.9	52	37.6	7.9	3.90	0	20	4.2	2.1	0	32	31.6	10.5	0
Big River-Reed	R+1	4.5	5.4	157	25.8	4	0.70	0	21.5	3.3	0.6	0	31	18	3	0
Big Piney	R+1	2.1	9.7	83	27.1	4.3	0.00	0	11.2	1.7	0	0	29	16	0	0
Eleven Point River	R+1	1.71	2.6	93	53.8	22.2	3.50	0	35.4	13	2	0	71	48	7	0
Elk River	R+1		4.8	669					97.42	14.01	3.55	0	26	18.45	3.65	0
James River	R+1		1.58	63					34.2	5.69	1.26	0	31	20	4	0
Joachim Creek	R+1	1	3.72	111	76	9	3.00	1	20.4	3.5	1.1	0.27	21	17.1	5.2	1.3
Meramec River	R+1	3.4	3.4	53	10	3.2	0.60	0	10	2.6	0.6	0	55.9	38.2	5.9	0
Mineral Fork	R+1	3.4	4.9	646	145.9	38.2	16.80	9.1	101.2	27.1	11.6	0.6	50.6	38.3	11.5	0.6
Osage Fork	R+1	3.55	5	489	20.3	2.6	0.20	0	72	9.4	0.8	0	26.2	14.1	1.1	0
Tenmile Creek	R+1	1.6	3.6	181	68	11	2.00	0	30	4.7	0.8	0	22	18	3	0
	R+1 total	**22.27**	**46.6**	**2597**												
	R+1 ave	**2.47**	**4.24**	**241.60**	**51.61**	**11.38**	**3.41**	**1.12**	**41.21**	**8.11**	**2.22**	**0.08**	**35.97**	**25.25**	**4.99**	**0.17**
Big River	R+2	3.88	8.15	330	40.9	10.1	3.40	0.26	19.4	4.8	1.6	0.12	43	32.9	8.2	0.63
Big River - Reed	R+2	3.5	4.9	160	39	6	2.00	0.3	27.6	4.3	1.4	0.2	31	21	5	1
Big Piney	R+2		13	218					10.5	2.9	0.9	0.2	48	36	9	1
Eleven Point River	R+2	1.71	2.7	89	44.4	15.2	8.20	0.6	28.1	8.6	5	0.4	66	53	18	1
Elk River	R+2		5	798					125.6	23.55	6.99	0	35	24.96	6	0
James River	R+2		2.56	68					24.2	3.13	2.7	0.4	44	24	11	2
Meramec River	R+2	6.9	9.3	283	36.4	6.1	2.30	0.4	27	4.8	1.7	0.3	39	24	6	1
Mineral Fork	R+2	3.4	4.7	667	136.2	34.1	9.10	1.5	98.5	25.7	6.6	1	45.6	33.8	6.7	1.1
Osage Fork	R+2	3.55	4.6	306	13.3	2.5	0.10	0	47.1	8.9	0.4	0	38.4	19.9	0.1	0
Tenmile Creek	R+2	1.6	4.1	187	83	11	5.00	0	34	4.4	2	0	28	19	6	0
	R+2 total	**24.54**	**5.901**	**3106**												
	R+2 ave	**3.51**	**5.90**	**310.60**	**56.17**	**12.14**	**4.30**	**0.44**	**44.20**	**9.11**	**2.93**	**0.26**	**41.80**	**28.86**	**7.60**	**0.77**
Big River	R+3	3.38	6	164	24.6	6.5	1.80	0.29	13.8	3.4	1	0.17	45	33.7	7.2	1.2
Big River-Upper	R+3	2.23	1.8	113	22	4	0.45	0	27.2	5	0.56	0	32.7	20.4	2	0
Big River-Reed	R+3	4	4.4	94	21	5.5	2.00	0	18.9	5	1.8	0	47	36	10	0
Big Piney	R+3		14.7	359					17.8	4.4	1.4	0.2	39	32	21	3
Eleven Point River	R+3	1.71	3.2	103	55	16.4	5.30	0.6	29.4	7.7	3	0.3	47	39	10	1
Elk River	R+3		5.8	578					87.1	20.17	6.61	0	47	31.34	8	0
Meramec River	R+3	6.9	9.4	290	33.3	8	2.00	0	24.5	5.9	1.5	0	47	30	6	0
Osage Fork	R+3	3.55	4.1	256	12.1	3.3	0.30	0	43	11.7	1.2	0	44.1	29.9	2.8	0
Tenmile Creek	R+3	1.3	2.1	103	50	16	7.00	0	31	10	4.3	0	54	46	14	0
	R+3 total	**23.07**	**51.5**	**2060**												
	R+3 ave	**3.30**	**5.72**	**228.89**	**31.14**	**8.53**	**2.69**	**0.13**	**32.52**	**8.14**	**2.37**	**0.07**	**44.76**	**33.15**	**9.00**	**0.58**

Post-SBBSMA Stream	Year	Stream Miles	Effort (Hours)	N	Catch ≥7"	Rate 12-15"	FISH/MILE ≥15"	≥18"	Catch ≥7"	Rate 12-15"	FISH/HOUR ≥15"	≥18"	PSD	RSD12	RSD15	RSD18
Big River	R+4	3.38	5.4	128	21	3.3	3.30	0.89	13.2	2.1	2	0.56	39	31	15.5	4.2
Big River-Upper	R+4	1.89	2.1	44	23.2	3.7	1.10	0	21	3.33	0.95	0	29	20	0.1	0
Big Piney	R+4		16.7	511					18.6	3.6	0.8	0	24	24	4	0
Meramec River	R+4	4.5	7.4	181	32.2	6.4	0.90	0.2	19.6	4.1	0.5	0.1	33.7	23.3	3	0.7
Osage Fork	R+4	3.55	3.9	172	9.9	2.8	0.30	0	35.1	10.1	1	0	46.3	31.6	2.9	0
	R+4 total	**13.32**	**35.5**	**1036**												
	R+4 ave	**3.33**	**7.10**	**207.20**	**21.58**	**4.05**	**1.40**	**0.27**	**21.50**	**4.65**	**1.05**	**0.13**	**34.40**	**25.98**	**5.10**	**0.98**
Big River	R+5	3.4	4.6	85	14.1	2.1	1.20	0.29	10.4	1.5	0.87	0.22	27	23	8.3	2.1
Eleven Point River	R+5	1.71	3.5	129	73	17.5	3.50	0	35.7	8	2	0	49	29	5	0
James River	R+5		1.06	52					42.5	16	2.8	0	56	44	7	0
Osage Fork	R+5	3.55	4.5	237	8.3	1.7	0.60	0	29.5	6.2	2	0	42.1	13.5	6.8	0
Tenmile Creek	R+5	1.6	3	164	67	14	3.00	0	36	7	1.7	0	37	25	5	0
	R+5 total	**10.26**	**16.66**	**667**												
	R+5 ave	**2.57**	**3.33**	**133.40**	**40.60**	**8.83**	**2.08**	**0.07**	**30.82**	**7.74**	**1.87**	**0.04**	**42.22**	**26.90**	**6.42**	**0.42**
Big River	R+6	1.04	1.9	52	39.4	7.7	1.90	0	21.6	4.2	1.05	0	38	24.2	4.9	0
Eleven Point River	R+6	1.71	3.3	126	67.8	19.9	4.10	0.6	35.1	10.5	2.2	0.3	63	35	6	1
James River	R+6		1.54	51					30.6	9.8	7.82	0.65	79	57	26	2
Meramec River	R+6	1.8	2.3	25	13.3	1.7	0.00	0	10.4	1.3	0	0	41.7	12.5	0	0
Tenmile Creek	R+6	0.7	1.8	82	70	20	3.00	0	27	7.7	1.1	0	45	33	4	0
	R+6 total	**5.25**	**10.84**	**336**												
	R+6 ave.	**1.31**	**2.17**	**67.20**	**47.63**	**12.33**	**2.25**	**0.15**	**24.94**	**6.70**	**2.43**	**0.19**	**53.34**	**32.34**	**8.18**	**0.60**
Big River	R+7	1.01	1.55	40	29.7	8.9	2.00	1	19.4	5.8	12.9	0.65	43	37	6.7	3.3
Big Piney	R+7	2.4	4.6		21.6	6.3	2.90	0	20.4	3.2	1.5	0	33.7	23.2	7.4	0
Eleven Point River	R+7	1.71	3.3	150	83.6	45	7.00	0.6	43.3	22.7	4	0.3	69	62	8	0.7
Meramec River	R+7	3.7	5	312	69.5	16.2	2.70	0	51.4	12	2	0	43.2	27.2	3.9	0
Osage Fork	R+7	3.55	5.5	189	6	1.4	0.30	0	21.4	4.8	1.2	0	33.9	25.4	5.1	0
Mineral Fork	R+7	1.6	2.9	150	70	17	4.00	0	38	20	7	0	49	30	6	0
	R+7 total	**13.97**	**22.85**	**841**												
	R+7 ave.	**2.33**	**3.81**	**168.20**	**46.73**	**15.80**	**3.15**	**0.27**	**32.32**	**11.42**	**4.77**	**0.16**	**45.30**	**34.13**	**6.18**	**0.67**
Big Piney	R+9	3.85	7.6		105.7	20	3.60	0	53.7	10.2	1.8	0	35.4	22.4	3.4	0
Big River	R+10	3.41	4.4	63	14.3	2.1	0.88	0.29	11.1	1.6	0.68	2.04	29	20	6.1	2.04
Big Piney	R+10	5.3	7.9		62.5	11.5	4.00	0.2	42.1	7.8	2.7	0.1	36.3	24.8	6.3	0.3
Meramec River	R+10	1.9	2.5	193	90	23.7	8.90	0.5	68.4	18.4	6.8	0.4	50.8	36.8	9.9	0.6
	R+10 total	**10.61**	**14.8**	**193**												
	R+10 ave	**3.54**	**4.93**	**128.00**	**55.60**	**12.43**	**4.59**	**0.33**	**40.53**	**9.27**	**3.39**	**0.85**	**38.70**	**27.20**	**7.43**	**0.98**
Big River	R+11	2.49	3	57	16.5	3.6	1.20	0.4	12.3	3	1	2.7	41	32	8.1	2.7
James River	R+11	2.8	3.33	36	10.71	5.71	2.14	0	9	4.8	1.8	0	77	73	20	0
	R+11 total	**2.49**	**3**	**57**												
	R+11 ave	**2.49**	**3.00**	**57.00**	**13.61**	**4.66**	**1.67**	**0.20**	**10.65**	**3.90**	**1.40**	**1.35**	**59.00**	**52.50**	**14.05**	**1.35**

Post-SBBSMA		Stream	Effort		Catch	Rate	FISH/MILE		Catch	Rate	FISH/HOUR					
Stream	**Year**	**Miles**	**(Hours)**	**N**	**≥7"**	**12-15"**	**≥15"**	**≥18"**	**≥7"**	**12-15"**	**≥15"**	**≥18"**	**PSD**	**RSD12**	**RSD15**	**RSD18**
Big River	R+12	2.64	2.3	27	8	1.5	0.00	0	9.1	1.7	0	0	30	19	0	0
Big Piney	R+12	4.2	9.5		96	24	7.20	0	61.2	15.3	4.6	0	43.6	32.4	7.5	0
James River	**R+12**	2.8	3.33	36	10.71	5.71	2.14	0	9	4.8	1.8	0	77	73	20	0
Meramec River	R+12	1.9	2.4	103	45.3	11.6	3.70	0	35.8	9.2	2.9	0	47.7	33.7	8.1	0
	R+12 total	**11.54**	**17.53**	**166**												
	R+12 ave	**2.89**	**4.38**	**55.33**	**40.00**	**10.70**	**3.26**	**0.00**	**28.78**	**7.75**	**2.33**	**0.00**	**49.58**	**39.53**	**8.90**	**0.00**
Big River	R+13	1.04	1.8	113	74	6.7	7.90	0.96	27.2	5	1	0	33	20	0.2	0
Big River	R+14	2.93	5	135	36.5	7.2	1.40	0.34	21.4	6	1	0.2	39	28	4	0.9
Big Piney	R+14	4.3	6.8		41.2	11.9	3.00	0	26.2	7.6	1.9	0	52.5	36.2	7.3	0
Meramec River	R+14	1.9	2.5	155	71.6	18.4	7.40	0.5	54	14	5.6	0.4	50	36	10.3	0.7
	R+14 total	**9.13**	**14.3**	**290**												
	R+14 ave	**3.04**	**4.77**	**145.00**	**49.77**	**12.50**	**3.93**	**0.28**	**33.87**	**9.20**	**2.83**	**0.20**	**47.17**	**33.40**	**7.20**	**0.53**
Big River	R+15	4.87	5.6	125	21.1	4.9	1.80	0	20	4.3	1.6	0	42	29.5	8	0
Big Piney	R+15	3.94	4.7		69.3	18.3	2.80	0	58.6	15.5	2.4	0	42.1	30.4	4	0
	R+15 total	**8.81**	**10.3**	**125**												
	R+15 ave	**4.405**	**5.15**	**125**	**45.2**	**11.6**	**2.30**	**0**	**39.3**	**9.9**	**2**	**0**	**42.05**	**29.95**	**6**	**0**
Post-regulation	**Average**	**4.62**	**6.99**	**285.86**	**44.08**	**10.77**	**3.02**	**0.31**	**32.92**	**7.95**	**2.39**	**0.19**	**42.80**	**30.60**	**6.93**	**0.49**
	Total	**416.23**	**669.08**	**26299**												

Pre-SBBSMA	Stream	Effort			Catch	Rate	FISH/MILE		Catch	Rate	FISH/HOUR					
Stream	**Year**	**Miles**	**(Hours)**	**N**	**≥7"**	**12-15"**	**≥15"**	**≥18"**	**≥7"**	**12-15"**	**≥15"**	**≥18"**	**PSD**	**RSD12**	**RSD15**	**RSD18**
Big River	R-1	1.76	4.2	170	60.2	13	2.80	0	25.2	5.5	1.19	0	51	26.4	4.7	0
Big River-Upper	R-1	1.32	2	106	58.3	11.4	1.50	0	38.5	7.5	1	0	31.1	22.1	2.6	0
Big River-Reed	R-1	8.25	11.1	274	28	5.6	1.20	0.1	20.8	4.1	0.9	0.1	36	18	4	0
Big Piney	R-1	4.2	5.76	113	41.2	8.6	1.70	0.2	30	6.3	1.2	0.2	42.8	24.9	4	0.6
Eleven Point River	R-1	1.71	2.9	79	40.9	11.7	2.90	0	24.1	7	2	0	51	36	7	0
Elk River	R-1		4.1	663					113.2	18.09	9.04	0	24.41	24.41	7.99	0
James River	R-1		3.62	101					19.4	10	1.1	0	64	57	6	0
Meramec River	R-1	10.2	11.1	234	12.9	1.4	0.20	0.1	11.9	1.4	0.2	0.1	31.1	12.9	1.5	0.7
Osage Fork	R-1	3.55	7.6	537	13.1	2.1	0.50	0	46.6	7.4	1.6	0	32.7	19.2	3.4	0
Tenmile Creek	R-1	2	3.8	194	76	21	8.00	0	39	11.1	4.2	0	49	38	11	0
	R-1 ave	**4.12**	**5.62**	**247.10**	**41.33**	**9.35**	**2.35**	**0.05**	**36.87**	**7.84**	**2.24**	**0.04**	**41.31**	**27.89**	**5.22**	**0.13**
	R-1 total	**32.99**	**56.18**	**2471**												
Big River	R-2	2.15	5.4	62	26.9	3.2	1.90	0.46	10.7	1.3	0.74	0.19				
Big River-Reed	R-2	3.5	3.3	70	16.3	3.4	0.30	0	17.3	3.6	0.3	0	42	23	2	0
Big Piney	R-2	4.2	7.6	163	43.3	6.9	2.40	0.7	23.9	3.8	1.3	0.4	34.6	21.4	5.5	1.6
Eleven Point River	R-2	1.71	3.2	109	59.1	14.6	4.60	0	31	7	3	0	53	33	8	0
James River	R-2		7.32	177					14.5	4.2	1.2	0	61	38	8	0
Meramec River	R-2	6.4	6.4	167	22.7	3.8	0.90	0.2	22.8	3.9	0.9	0.2	37.2	21.4	4.1	0.7
Mineral Fork	R-2	4	5.3	588	77.3	13.8	4.00	0.8	58.3	10.4	3	0.6	35.3	23.9	5.2	1
Osage Fork	R-2	3.55	8.4	440	10.9	1.9	0.30	0	38.6	6.8	1.1	0	31.4	20.3	2.8	0
Tenmile Creek	R-2	2	5.4	163	82	27	5.00	0	30	10	1.9	0	46	39	6	0
	R-2 ave	**3.44**	**5.81**	**215.44**	**42.31**	**9.33**	**2.43**	**0.27**	**27.46**	**5.67**	**1.49**	**0.15**	**42.56**	**27.50**	**5.20**	**0.41**
	R-2 total	**27.51**	**52.32**	**1776**												

Pre-SBBSMA		Stream	Effort		Catch	Rate	FISH/MILE		Catch	Rate	FISH/HOUR					
Stream	**Year**	**Miles**	**(Hours)**	**N**	**≥7"**	**12-15"**	**≥15"**	**≥18"**	**≥7"**	**12-15"**	**≥15"**	**≥18"**	**PSD**	**RSD12**	**RSD15**	**RSD18**
Big River-Upper	R-3	0.37	0.8	20	48.6	13.5	2.70	0	22.5	6.3	1.3	0	44.4	33.3	5.6	0
Big River-Reed	R-3	8.25	13.4	528	53.8	9.6	3.20	0.2	33.1	7.8	1.9	0.1	35	24	6	0
Elk River	R-3		2.99	400					95.65				29.62	16.72	3.14	0
James River	R-3		1.68	15					8.9	0	0	0	13	0	0	0
Tenmile Creek	R-3	1.6	3.5	141	65	17	9.00	0	29	7.7	4	0	53	39	14	0
	R-3 ave	**3.41**	**4.47**	**220.80**	**55.80**	**13.37**	**4.97**	**0.07**	**37.83**	**5.45**	**1.80**	**0.03**	**35.00**	**22.60**	**5.75**	**0.00**
	R-3 total	**10.22**	**22.37**	**1104**												
Big River-Upper	R-4	2.23	2.4	52	26.4	4.5	1.80	0.9	24.5	4.2	1.7	0.83	28.8	24.4	4.9	0
Big River-Reed	R-4	8.25	10	443	36.9	6.8	2.90	0.2	30.6	5.6	2.4	0.2	38	26	8	1
Elk River	R-4		2.17	201					80.65	9.21	4.61	0.46	24.57	17.81	6.32	0.57
James River	R-4		3.6	113					27.5	3.3	0.8	0	28	15	3	0
Joachim Creek	R-4	1	3.87	140	84	14	1.00	0	21.7	3.6	0.3	0	30.9	17.8	1.1	0
Tenmile Creek	R-4	1.6	2.65	60	24	5	0.00	0	14	3	0	0	37	21	0	0
	R-4 ave	**3.27**	**4.12**	**168.17**	**42.83**	**7.58**	**1.43**	**0.28**	**33.16**	**4.82**	**1.64**	**0.25**	**31.21**	**20.34**	**3.89**	**0.26**
	R-4 total	**13.08**	**24.69**	**1009**												
Big River-Upper	R-5	2.24	2.3	34	13.4	1.8	0.45	0.45	13.3	1.8	0.44	0.44	23.3	16.7	3.3	3.3
Elk River	R-5	2.8	4.52	359	78.92	15.71	5.35	0	49	9.73	3.32	0	39.19	26.24	6.76	0
Mineral Fork Creek	R-5															
	R-5 ave	**2.52**	**3.41**	**196.50**	**46.16**	**8.76**	**2.90**	**0.23**	**31.15**	**5.77**	**1.88**	**0.22**	**31.25**	**21.47**	**5.03**	**1.65**
	R-5 total	**5.04**	**6.82**	**196.5**												
Big River-Upper	R-6	2.47	3.9	133	34.4	1.6	4.00	1.2	21.2	1	2.6	0.77	29.4	16.5	11.8	3.5
Elk River	R-6		1.46	80					45.9	6.1	2	0	18.8	11.59	4.34	0
Meramec River	R-6	0.5	1.1	18	28	4	4.00	0	12.7	1.8	1.8	0	42.9	28.6	14.3	0
Mineral Fork	R-6	1.3	1.5	36	24.6	8.5	4.60	0	21.3	7.3	4	0	69	53	19	0
Tenmile Creek	R-6	0.6	1.4	23	25	15	2.00	0	11	6.4	0.7	0	87	66	7	0
	R-6 ave	**1.22**	**1.87**	**58.00**	**28.00**	**7.28**	**3.65**	**0.30**	**22.42**	**4.52**	**2.22**	**0.15**	**49.42**	**35.14**	**11.29**	**0.70**
	R-6 total	**4.87**	**9.36**	**290**												
Big River-Upper	R-7	2.64	5.3	151	28	3.8	4.50	2.3	14	1.9	2.3	1.1	39.1	29.7	16.2	8.1
Big River-Upper	R-8	2.48	2	51	7.7	1.2	0.40	0.4	9.5	1.5	0.5	0.5	31.6	21	5.3	5.3
Big River-Upper	R-9	0.95	1.65	32	25.2	1.1	0.00	0	14.6	0.61	0	0	12.5	4.2	0	0
Big River-Upper	R-10	2.83	1.35	69	18.7	2.8	0.35	0.35	39.3	5.9	0.74	0.74	32	17	1.9	1.9
Big River-Upper	R-11	1.32	2.2	61	29.5	5.3	0.76	0.76	17.7	3.2	0.45	0.45	33.3	20.5	2.6	2.6
Pre-regulation	**Average**	**4.81**	**7.26**	**296.01**	**40.25**	**8.64**	**2.68**	**0.25**	**30.55**	**5.61**	**1.82**	**0.16**	**38.65**	**25.83**	**6.00**	**0.66**
	Total	**211.47**	**377.73**	**15393**												

R = Regulation Date (Year)

Appendix 3. Average length at age for pre- and post-SBBSMA smallmouth bass, 1990-2007.

Post-SBBSMA Stream		Stream	Effort		Length @ Age									
Stream	**Year**	**Miles**	**(Hours)**	**N**	**Age 1**	**Age 2**	**Age 3**	**Age 4**	**Age 5**	**Age 6**	**Age 7**	**Age 8**	**Age 9**	**Age 10**
Big River	R	1.19	2.05	99	4	6.7	9.2	11.7	13.1	16.9				
Big Piney	R	4.2	3.7	89		6.5	8.6	10.5	12.2	14.2	17.1			
	R ave				**4.00**	**6.60**	**8.90**	**11.10**	**12.65**	**15.55**	**17.10**			
Big River	R+1	1.01	1.9	52	3.1	6.4	9.5	11.8	12.7	14.3	16			
Big Piney	R+1	2.1	9.7	83		6.2	8	10.1	11.4	13.2	14.6			
Elk River	R+1		4.8	669	3.6	6.5	9.1	11.3	13.1	14.4	15.3	16	16.9	17.4
Osage Fork	R+1	3.55	5	489	3.3	5.7	7.9	9.8	11.9	13.1	12.8			
Tenmile Creek	R+1	1.6	3.6	181	5	6	8.7	10.9	13.3	14.5	15.3			
	R+1 ave	**2.47**	**4.24**	**241.60**	**3.75**	**6.16**	**8.64**	**10.78**	**12.48**	**13.90**	**14.80**	**16.00**	**16.90**	**17.40**
Big River	R+2	3.88	8.15	330	3.1	5.5	8.5	10.4	12.6	13.8	15.1			
Elk River	R+2		5	798	3.7	6.7	9.3	11.3	12.9	14.2	15.4	16.3	17.52	17.7
Meramec River	R+2	6.9	9.3	283	3.8	6.4	8.8	10.2	11.2	12.8	14.4	16.5		
Osage Fork	R+2	3.55	4.6	306	3.6	6	7.8	10.6	11.9	13.4	15			
	R+2 ave	**3.51**	**5.90**	**310.60**	**3.55**	**6.15**	**8.60**	**10.63**	**12.15**	**13.55**	**14.98**	**16.40**	**17.52**	**17.70**
Big River	R+3	3.38	6	164	3.8	6.9	9.3	10.7	12.4	13.8	14.9	17.7		
Osage Fork	R+3	3.55	4.1	256	3.7	6.1	8.4	11.3	13.6	14.8				
Tenmile Creek	R+3	1.3	2.1	103										
	R+3 ave	**3.30**	**5.72**	**228.89**	**3.75**	**6.50**	**8.85**	**11.00**	**13.00**	**14.30**	**14.90**	**17.70**		
Big River	R+4	3.38	5.4	128	3.2	6.1	9	11.4	12.9	14.9	16.6	17.4		
Big Piney	R+4		16.7	511		5.1	7.5	10.7	12.5	14	14.7	16.4		
Big River-Upper	R+4	1.89	2.1	44	3.31	5.46	7.55	9.43	11.71	13.44				
Meramec River	R+4	4.5	7.4	181	3.6	6.2	8.6	10.4	11.9	13.4	15	16.2		
Osage Fork	R+4	3.55	3.9	172	3.8	6.3	8.9	11.8	14.2	15.4				
	R+4 ave	**3.33**	**7.10**	**207.20**	**3.48**	**5.83**	**8.31**	**10.75**	**12.64**	**14.23**	**15.43**	**16.67**		
James River	R+5		1.06	52	5.13	7.56	10.31	11.92	13.46	15.74				
Osage Fork	R+5	3.55	4.5	237	3.4	5.8	7.9	10.4	13	14.4	15	17.95		
	R+5 total	**10.26**	**16.66**	**667**										
	R+5 ave	**2.57**	**3.33**	**133.40**	**4.27**	**6.68**	**9.11**	**11.16**	**13.23**	**15.07**	**15.00**	**17.95**		
Osage Fork	R+7	3.55	5.5	189	3.8	6	8	10.4	12.8	15	16.2			
James River	R+11	2.8	3.33	36		7.46	10.64	12.92	14.86	16.14				
Post-regulation	**Average**				**3.74**	**6.27**	**8.71**	**10.91**	**12.71**	**14.37**	**15.25**	**16.66**	**17.11**	**17.50**

Pre-SBBSMA

Stream	Year	Miles	(Hours)	N	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10
Big River-Reed	R-1	8.25	11.1	274	6.9	8.1	9.7	11.7	13.7					
Big Piney	R-1	4.2	5.76	113	3.3	5.5	8	9.8	11.6	13.6	15.1	17.6		
Elk River	R-1		4.1	663	3.9	7.1	9.5	11.4	12.8	14.2	15.1	15.4	15.7	
James River	R-1		3.62	101	4.8	7.2	11.5	12.4	13.5	14.5	16.3			
Osage Fork	R-1	3.55	7.6	537	3.3	5.7	7.8	10.1	11.9	13.9	15.9	16.9		
	R-1 ave				**4.35**	**6.75**	**9.40**	**11.27**	**13.05**	**14.46**	**15.60**	**16.63**	**15.70**	
Big Piney	R-2	4.2	7.6	163	3.1	6	8.3	10.2	11.9	14.2	15.4	17.1		
James River	R-2		7.32	177	4.8	6.7	10.6	12.2	13.6	15	16.8			
Meramec River	R-2	6.4	6.4	167	4.4	6.4	9.2	11.4	13.5	15	17.4	18		
Osage Fork	R-2	3.55	8.4	440	3.2	5.5	8.6	11.8	14	15.3	16	16.8		
	R-2 ave				**3.88**	**6.15**	**9.18**	**11.28**	**13.25**	**14.88**	**16.40**	**17.30**		
Big River-Reed	R-3	8.25	13.4	528			9.5	10.4	13.5	15.6				
Elk River	R-3		2.99	400	3.8	6.8	9	10.6	11.9	13.1	14.4			
Tenmile Creek	R-3	1.6	3.5	141	4.7	6.3	8.8	11.2	13.1	14.5	16.4			
	R-3 ave				**4.25**	**6.55**	**9.10**	**10.73**	**12.83**	**14.40**	**15.40**			
Elk River	R-4		2.17	201	3.9	7.1	9.2	12.2	13.7	15.1	16.1	16.3		
James River	R-4		3.6	113	4.8	6.7	9.2	11.4	12.7		16.3			
Joachim Creek	R-4	1	3.87	140	4.93	6.81	9	11.49	12.84	16				
Tenmile Creek	R-4	1.6	2.65	60	4.2	6.6	9.4	11.2	13.7	14.7				
	R-4 ave				**4.46**	**6.80**	**9.20**	**11.57**	**13.24**	**15.27**	**16.20**	**16.30**		
Elk River	R-5	2.8	4.52	359	3.7	6.4	8.6	10.9	12.8	15				
Mineral Fork Creek	R-5				3.83	6.66	8.39	10.77		15.91				
	R-5 ave				**3.77**	**6.53**	**8.50**	**10.84**	**12.80**	**15.46**	**15.70**	**16.06**		
Big River-Control	R-6	2.47	3.9	133	3.1	6	8.6	10.8	12.2	15	16.7	17.8		
Elk River	R-6		1.46	80	5.1	6.9	8.6	10.2	11.7	14.7	15.1			
	R-6 ave				**4.10**	**6.45**	**8.60**	**10.50**	**11.95**	**14.85**	**15.90**	**17.80**		
Big River-Upper	R-7	2.64	5.3	151	3.9	6.8	9	10.9	14	15.5	17.4	18.5		
Big River-Upper	R-8	2.48	2	51	3.4	5.6	8.6	11.5	13.8		17.3	18.3		
Big River-Upper	R-9	0.95	1.65	32	3.6	6.7	9.9	11.1	14.3					
Big River-Upper	R-10	2.83	1.35	69	4.1	6.4	9.5	11.7	12.9	15.2	19.5			
Big River-Upper	R-11	1.32	2.2	61	3.4	6.7	9.1	11	16.3	19				
Pre-regulation	**Average**				**4.12**	**6.54**	**9.10**	**11.12**	**13.06**	**14.85**	**16.04**	**17.12**		

R = Regulation Date (Year)